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A COMPARISON OF TRADITIONAL AND NON-TRADITIONAL MANAGEMENT CONTROL SYSTEMS

by

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June, 1994

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The Department of the Navy's approach to total quality management has been evolving for over a decade. Although, tremendous strides have been made at the highest levels within DON, resistance remains at the lower levels. Management control systems within the Government and particularly the military are very much traditional in nature. Adoption of total quality management necessitates a change of the current management control system. The authors compare a theoretical model of a traditional management control system with common elements of a total quality management control system. They also conduct a case study of an actual management control system in a corporation that successfully adopted the philosophy of total quality management. Modeling both types of management control systems and comparing both models to an actual total quality management control system provides a framework for stimulating discussion and learning at all levels in Department of the Navy, the Department of Defense, and other Government Agencies.

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A Comparison of Traditional and Non-traditional
Management Control Systems

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ABSTRACT

The Department of the Navy's approach to total quality management has been evolving for over a decade. Although, tremendous strides have been made at the highest levels within DON, resistance remains at the lower levels. Management control systems within the Government and particularly the military are very much traditional in nature. Adoption of total quality management necessitates a change of the current management control system. The authors compare a theoretical model of a traditional management control system with common elements of a total quality management control system. They also conduct a case study of an actual management control system in a corporation that successfully adopted the philosophy of total quality management. Modeling both types of management control systems and comparing both models to an actual total quality management control system provides a framework for stimulating discussion and learning at all levels in Department of the Navy, the Department of Defense, and other Government Agencies.

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loving, patient, and understanding families;
and two very patient and understanding Professors.

I. INTRODUCTION

A. BACKGROUND

On February 10, 1992, strategic goals for the Department of the Navy (DON) were signed by the Secretary of the Navy, the Chief of Naval Operations, and the Commandant of the Marine Corps. This was the first document of its kind and it said, in effect, that the entire organization (DON) would focus on Quality as it plots its course for the future. The Guiding Principles further state that . . . "We (DON) have adopted the term *Total Quality Leadership* (TQL) as the general term by which we will pursue total quality efforts." The stated purpose of the foregoing document was to firmly set DON on a course of total quality (TQ). By adopting TQL, DON made the commitment to continuous improvement of its systems and processes. One of its most important systems is that of the management control.

The Government Performance and Results Act of 1993 (Public Law 103-62) mandates reinventing government for the stated objectives of; improving public confidence in government, supporting management improvement and innovation, focusing oversight and strengthening accountability, adapting successful models of other governments, and providing management flexibility in exchange for accountability. It is emphatically clear that

the mission for all government agencies, particularly Military, is to transform their management control systems.

Although management control might conjure up notions of financial accounting, that is not in the purview of this thesis topic. Our purpose is not to suggest changes to the organization's financial accounting system. Financial accounting, as defined by Stickney, concerns the preparation of reports for use by persons outside the organization (Stickney, 1991, p. 23). These financial reports have been standardized in generally accepted accounting principles established by the Financial Accounting Standards Board (FASB) and the Securities and Exchange Commission (SEC). Hence, financial accounting reports can only be changed by either of these two rule-making bodies.

The term "management control system" or "MCS" is used in this thesis to describe the system used by managers to control a process or processes to obtain a desired outcome, or in other words, optimization of the system. To achieve optimization, all systems must be managed, and large systems such as the military are more difficult to manage. The literature has shown that many management control systems have produced sub-optimal results even though managers and workers are putting forth their best effort. This sub-optimization results from a lack of a theory of management for optimization, or lack of knowledge (Walton, 1991, p. 9) The aim of this thesis is to increase knowledge of

management control systems as they apply to TQ focused organizations.

The Department of the Navy's approach to total quality management systems has been evolving for over a decade. Although, tremendous strides have been made at the highest levels within DON, resistance remains at the lower levels (Suarez, 1993, p. 1). This resistance is fostered by a lack of knowledge and understanding of the philosophy of total quality management.

Because of budget shortfalls and other ever increasing demands on resources, most managers are feeling overwhelmed by routine and crisis management requirements. Education and training required for the transformation to total quality management is often relegated to a "back burner." Because of these constraints, government managers are in need of an easily understood blue print or model for making the transformation mandated in the Government Performance and Results Act. The aim of this thesis is to do just that. Modeling both types of management control systems and comparing both models to an actual total quality management control system will provide managers with a useful tool for grasping the fundamental concepts of the total quality management philosophy and total quality management control systems.

Hopefully, this thesis will provide an impetus for stimulating discussion and learning on the applicability of

Total Quality Management Control Systems (TQMCS) at all levels of management within DON, the Department of Defense (DOD), and other Government Agencies.

B. OBJECTIVES

The objective of this thesis is to provide Department of the Navy and other concerned government managers a concise and compact reference for comparing traditional and total quality models of management control systems and making judgements for their use in pursuit of their vision, guiding principles, and strategic goals. It explores the differences that exist in how traditional management control systems and total quality management control systems achieve their management objectives. The primary research objectives are to (1) compare a theoretical model of a traditional management control system with a theoretical model of a total quality management control system; and (2) conduct a case study of an actual management control system in a corporation that has successfully adopted, or is in the process of adopting, the philosophy of total quality management. Additionally, the mental models behind both systems are compared, and the identifiable differences in both management control systems are analyzed.

C. RESEARCH QUESTIONS

The following specific research questions are addressed in this thesis:

- What are the commonly held mental models that form the foundations of both types of Management Control Systems?
- What is a Total Quality Management Control System?
- What are the similarities and differences between the Traditional and Total Quality Management Control Systems?

D. DEFINITIONS

Different words have different meanings, or schema, for different people. Therefore, the following definitions apply to this thesis and are included to ensure clarity of meaning for the reader.

1. Management

Management as defined by Webster is the art, act, or manner of managing, handling, controlling, or directing. In this thesis, management is used in context of leading and long-term planning.

2. Control

Webster's definition of Control, as checking or verifying by comparison with a duplicate register, is used in this context for this thesis.

3. Creators

Webster defines a creator as someone who creates things. Used in the context of this thesis, creators are the individuals in an organization who are charged with the

responsibility for producing a product or service. Creators may produce a product or service alone or they may produce their product or service as part of a team.

4. Culture

The American Heritage Dictionary defines culture as the totality of socially transmitted behavior patterns, arts, beliefs, institutions, and all other products of human work and thought. In essence, the sum of all the patterns, traits, expressions, and products of an organization are the culture of that organization. Culture also implies enlightenment attained through close association with and appreciation for the highest level of civilization. "Culture is then properly described not as having its origin in curiosity, but as having its origin in the love of perfection" (Matthew Arnold, 1869). Culture also gives the organization its capacity, or taste, for recognizing and appreciating what is fitting, proper, or morally right, its values. "These questions of taste, of feeling, of inheritance, need no settlement. Every one carries his own inch-rule of taste" (Henry B. Adams, 1918).

5. Vision

As defined by Webster, a vision is a mental image produced by the imagination. In the context of this thesis, vision will convey the meaning of an organization's picture of where it wants to be at some point in the future; five, ten, or even one hundred years from now.

6. Value

Webster defines a value as a principle, standard, or quality considered worthwhile or desirable. Every organization has values, some are explicit and some are hidden. Values determine how an organization will pursue its vision and mission.

7. Mission

Mission, in the American Heritage Dictionary, is defined as the business with which a body of persons is charged. Elements contributing to the mission of an organization will always be measurable, how many flight hours flown etc.

8. Strategy

Webster defines strategy as "the science of planning and directing large-scale military operations or a skill in managing and planning." In the context of this thesis, strategy is a long-term plan of action congruent with vision, mission, and within the values of an organization. For example, a company's decision to produce one high quality product line verses producing many products at the low end of the quality scale is an example of a strategic decision.

9. Mental Models

"Mental models are deeply ingrained assumptions, generalizations, or even pictures or images that influence how we understand the world and how we take action." (Senge,

1990, p. 8) For example, two people looking at a picture of the sun on the earth's horizon might have very different mental models of that picture. One may see it as a sunrise and the other may see it as a sunset. People and organizations are often not aware of these mental models and how they effect what they chose to do.

10. Management Control

"Management control" is simply the process by which managers ensure that the organization achieves its goals and strategies effectively and efficiently (Anthony, 1992, p. 3).

Management control systems encompass two major processes; management and control. While management can be illustrated as the process of selecting which way to go, control is the process by which the organization ensures that it follows the intended path. Therefore, management and control are not identical, they are two separate concepts.

These major processes, management and control, encompass several sub-processes:

- Developing a vision and a set of values
- Long-term, strategic planning
- Short-term planning
- Assigning authority and responsibility to individuals and groups in the organization
- Deciding what to measure to assure that organization is moving in the right direction
- Deciding how to measure it (control)
- Setting standards to compare the measurements to
- Creating incentives to steer the organization's members on the desired track

As Figure 1 illustrates, every organization has constraints, values, and strategies which create an explicit or implicit path that it follows towards achieving its vision. Values create a fairly permanent outer boundary. However, the boundaries on the inner path are highly flexible. Organizations use management control to navigate along this changing path. Of course organizations differ in their vision, values, strategies and goals, and therefore in the way they manage themselves.

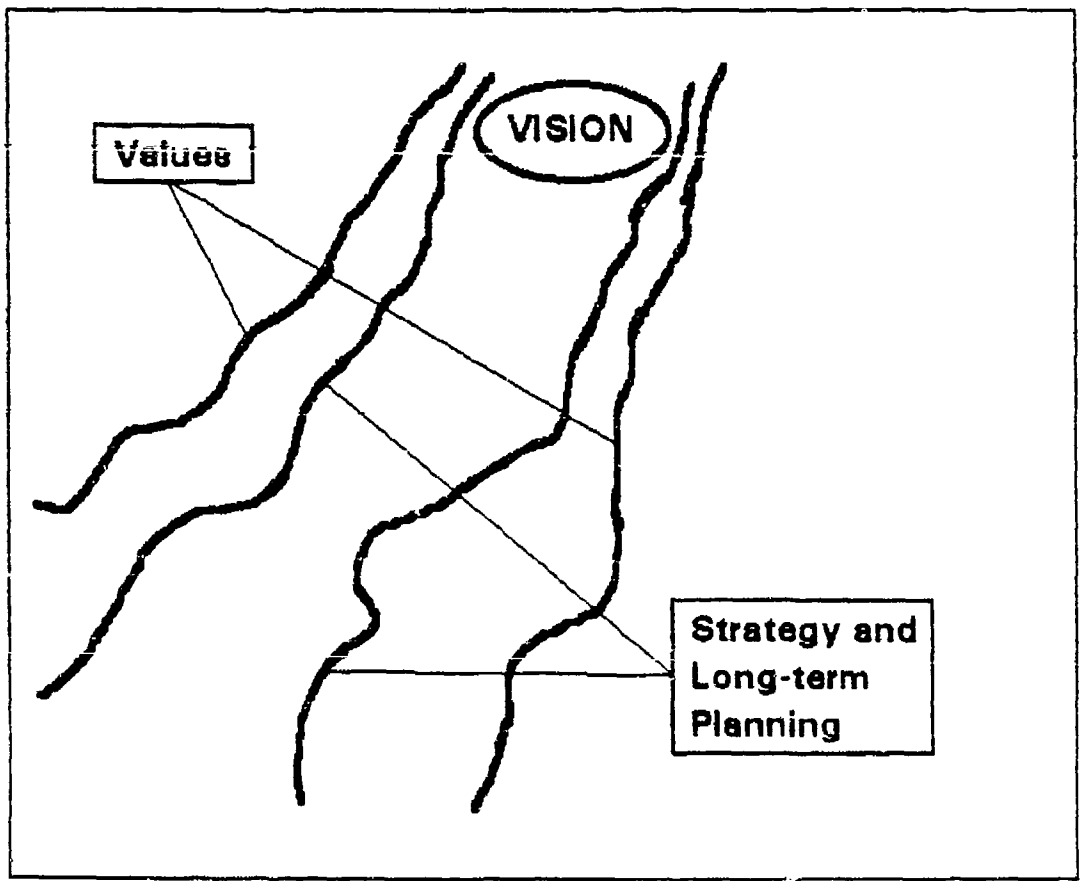

Figure 1. Organizations pursue their Vision within the constraints of Values and Strategy (Long-term Planning).

E. SCOPE OF THESIS

This thesis focuses on the concept of management control and compares the differences that exist between traditional and total quality management control systems.

The foundation of the thesis is a 16 month concentrated study of the preponderance of literature on both the traditional and total quality management control systems. The analysis of military management control and the applicability of total quality management control systems to the military is based on the cumulative 48 years of both authors' military experience, which involved varying degrees of leadership roles.

The thesis also contains information gained from a case study of a leading manufacturer of premium quality medical diagnostic equipment that is transforming itself to a total quality organization. The case study is limited to the Systems Manufacturing Department of this organization; however, the boundaries which separate ACUSON Systems Manufacturing from the rest of the corporation are not always clear. Most of the interviewees belong to systems manufacturing, though, some did belong to other departments as well. The interviewees were selected by management. Information from a previous survey commissioned by ACUSON and conducted by an outside consulting firm was also used.

F. ASSUMPTIONS AND LIMITATIONS

1. Assumptions

In order to complete this thesis study, it was necessary to make the following assumptions:

- The information gained from our interviews was not biased by management's selection of the interviewees
- The authors' knowledge of Military Management Control Systems, primarily at the mid and lower levels of management, is cogent
- The previous survey commissioned by ACUSON was conducted correctly and that the data it contained was accurate and unbiased
- Management control systems are universal and are applicable to any industry of processes

2. Limitations

This thesis was limited by the following factors:

- Interviewees for the case study were chosen by ACUSON management.
- Accuracy of the survey previously commissioned by ACUSON
- Limited information available on TQMCS. The literature available on the subject of total quality contained very little on management control systems.

G. THESIS ORGANIZATION

The content and organization of this thesis are summarized as follows:

Chapter II provides an overview of the methodology for this thesis. It discusses the methods used for the literature review, model development, comparative analysis, and the case study.

Chapter III describes a model of a traditional management control system. It discusses the commonly held mental models and characterizes the processes whereby

traditional managers control the organization for the obtainment of goals and objectives.

Chapter IV describes the fundamentals of total quality management control systems.

Chapter V describes the Canon Production System (CPS) model for a TQMCS. It discusses Canon's commonly held mental models and characterizes the processes whereby Canon management controls the organization for the obtainment of its goals and objectives.

Chapter VI describes the GOAL/QPC approach to a TQMCS. It discusses the GOAL/QPC approach's commonly held mental models and characterizes the processes whereby GOAL/QPC would have management control the organization for the obtainment of its goals and objectives.

Chapter VII identifies the common elements of a total quality management control system.

Chapter VIII is a comparison of traditional and total quality management control systems.

Chapter IX is a case study of ACUSON'S Systems Manufacturing (ASM) management control system.

Chapter X summarizes the results of this study and gives the authors' conclusions and recommendations for ACUSON Corporation and DOD. This chapter suggest areas that might warrant further study or examination.

II. METHODOLOGY

A. LITERATURE REVIEW

A manual search of the Dudley Knox Library was conducted using BOSUN terminals located in the library. Additionally, a search of the two principle databases (SABIRS and DTIC) available to the Dudley Knox library research staff was conducted using the following keys words: Control, Management Control, Total Quality, Total Quality Management Control, Models, Modeling, Research, and Evaluation. Current publishers' catalogs were reviewed for the purpose of identifying the most current literature related to the topic.

An extensive examination of this literature (see List of References) was then conducted by both authors. The objective of this examination was to gain information on both traditional and total quality management control systems.

References on the subject of modeling were also consulted to gain insight into constructing the applicable models.

B. DEVELOPMENT OF MODELS

1. Traditional Management Control System (TMCS) Model

The TMCS is well-defined in literature, hence, the authors only had to use content analysis of current models to determine one generic model.

2. Total Quality Management Control System (TQMCS) Model

To develop a generic model, the authors concentrated on two examples: The Canon Production System and GOAL/QPC models. These two TQMCS were chosen by the authors because they were more clearly defined and better documented than the rest of the literature. A comparison of these two models produced elements that were common to both models. These elements were further corroborated with the theories of Deming, Juran, Senge, and others.

C. COMPARATIVE ANALYSIS

The generic model of a TMCS, outlined in Chapter III, and the common elements of a TQMCS (Chapter VII) were compared on a number of dimensions. Dimensions were defined as an attribute of a management control system. They were chosen by examining the mental models and structure and operation of the two systems; if an attribute was important to either a TMCS or TQMCS, it became a dimension for purposes of comparison and analysis. The authors grouped these dimensions into groups and ultimately into categories. Each MCS was then compared within each of the dimension, groups, and categories.

C. CASE STUDY

The methodology for the case study will be discussed in detail in Chapter IX, however, it consisted of the following elements:

- Gaining entry into company
- Conduct personnel interviews
- Observe processes during walk-arounds and listen or be attentiveness to individuals conversing in the companies common cafeteria
- Review of ACUSON'S past and present annual report to shareholders
- Review of previous Continuous Improvement Survey commissioned by ACUSON

III. TRADITIONAL MANAGEMENT CONTROL SYSTEM

The purpose of this chapter is to identify some of the assumptions and mental models upon which the Traditional Management Control System is based. The chapter begins with a description of a Traditional Management Control System then progresses to an examination of its mental models. Finally, a typical Military Management Control System is described. The description of the traditional management control system is from the managerial financial point of view.

A. DESCRIPTION OF A TRADITIONAL MANAGEMENT CONTROL SYSTEM

Management control is the process by which managers influence other members of the organization to implement the organization's strategies. Management control fits between two activities, strategic planning and task control. Task control focuses on short-run operating activities and uses accurate current data. Strategic planning focuses on the long-run and uses rough approximations of the future. Management control falls within the boundaries of task control and strategic planning (Anthony, 1992, p. 9).

Another definition of a management control system is: "The process by which an organization influences the behavior of its members to insure, as far as possible, the

achievement of the organization's objectives. As such, activities like goal setting, performance evaluation, and reward administration are all viewed as elements of a control system." (Ferris, 1987, p. 177). The next section describes a "typical" traditional management control system.

Under traditional management control systems, top management determines the mission, vision, values and strategic goals for the organization (see Figure 2). Then top management coordinates and sets a long term plan and a budget (which is a detailed plan for the coming year.) Top management publishes a mission statement, corporate policies, a plan and a budget. All the organization's members must follow the guidelines mentioned above.

Top management expects managers and workers to have their own agenda; they are expected to pursue their own good and not necessarily follow the organization's policies, values and goals. To make sure that everyone obeys, *management* controls the organization.

It is management's role to plan and to make sure that the plans are observed. To fulfill this role traditional management uses some mechanisms:

1. Planning and Budgeting

Companies have complicated methods of setting numerical goals. The purpose of this process is to assure that subunits and individuals in the organization are moving toward accomplishing these goals.

2. **Reports**

Many reports are used to inform upper levels to what extent the goals are achieved. Other reports are used as a source of information for management about "what's going on" in the organization. Examples of reports:

a. Daily Reports

Used to gain information about daily sales, daily production, and number of customers served in the previous day.

b. Monthly Expenses Reports

Used to capture information regarding the cost of operations such as water bill, electric bill, phone bill, etc.

c. Financial Reports

Used to determine residual income (RI) or return on investment (ROI) for measuring investment center performance; profit before interest and income tax (PBIT) for measuring a profit center performance; cost and revenue for measuring cost and revenue center performance, respectively.

d. Non-Financial Reports

Used for tracking information such as customer complaints, employee turnover, worker absenteeism rate.

3. **Incentives**

The information gathered by the reports and by other methods is used to determine who deserves a reward (such as

profit sharing, stock options, bonuses, promotion, rewards to workers not taking sick leave) or a punishment. Many companies tie executives' wages to measurable criteria like income or ROI. These companies believe that this is the way to motivate executives: through their compensation.

4. Limited Responsibility and Authority

By limiting responsibility and authority of individuals in an organization, management can distinguish between different units and measure each unit separately. Examples of limited authorities and responsibilities:

- A marketing person has only the authority to give a limited discount. His responsibilities are limited to the amount of dollar sales and he is measured by this criterion
- A manufacturing plant manager has limited authority to spend money on unscheduled maintenance. If additional funds are required, he must obtain approval from higher authority. The manager is measured on the number of units produced and the cost of production (a cost center)

By using these mechanisms, management believes they motivate individuals to follow the organization's objectives. In case of a unit that performs poorly or violates a corporate rule, management takes correction steps.

Different organizations use different management control systems. However, there are some common elements that affect management control systems such as mental models, expectations, habits, managers' personalities, business of the organization (semiconductor manufacturing, cars manufacturing, banking, hotels, health care, a

government agency, a navy ship etc.), culture of the organization, competitive environment, size of the unit, managerial information technology, and rules and regulations in the state or country wherein the unit operates. Different units within an organization may also (and probably do) have different management control systems.

Although management control systems may be affected by all of the elements just mentioned, of particular interest are the mental models that serve as the conceptual base on which management control systems are constructed.

Mental models held by an organization's members form the foundation upon which the organization is built. Mental models are the beliefs or hidden assumptions which influence the way we receive and process information. We will discuss the mental models underlying traditional management control systems in the next section.

In the TMCS, see Figure 2, top management is at the top of the organization and from that position dictates policy and regulations, through the management control system, to middle management and on down to the work force. After dictating policies and regulations, management then uses the management control system to verify that the organization is following the policies and decisions of top management.

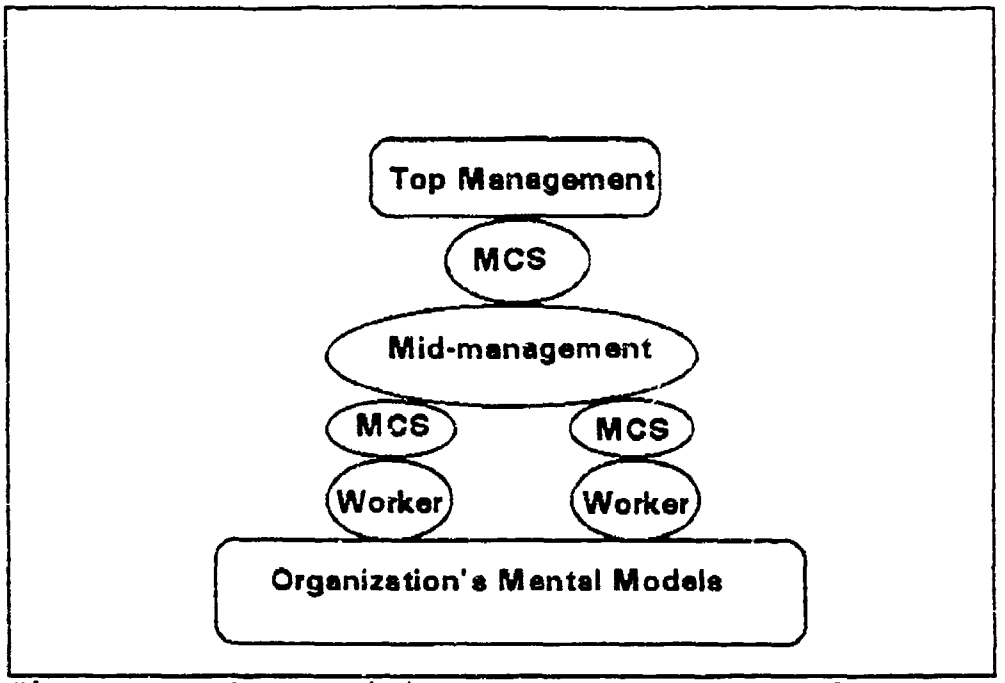

Figure 2. The Traditional Management Control System.

B. MENTAL MODELS REGARDING TRADITIONAL MANAGEMENT CONTROL SYSTEMS

1. Mental Models regarding Planning and Problem Solving

a. Only top management controls the organization.

Management control systems provide the means by which management controls the organization. Strategic plans, measurements, promotions, incentives, are all determined by top management. Anthony says that "an organization must also be controlled, that is, there must be devices that ensure that it [the organization] goes where its leaders want it to go." (Anthony, 1992, p. 3) The name "Management Control System" implies that control and

management are in the territory of top management. That brings us to the next assumption:

b. Only management manages the organization.

Decisions are made by management. Objectives, goals, and plans are all set by management. Different layers of management are involved in the management process. Traditional organizations give different degrees of freedom to different layers of management. The final word is reserved for the manager higher in the hierarchy. A consensus, or real commitment, at the lower layer of management is a "nice to have" but not a necessity.

The next assumption deals with the interrelationship between objectives within organizations.

c. An organization achieves its objectives if the sub-units achieve their assigned objectives.

The idea behind responsibility centers is that the organization is divided into sub-units (responsibility centers) and each sub-unit must achieve certain objectives established by top management. "The objectives of responsibility centers are to do their part in implementing these strategies. Because the organization is the sum of all the responsibility centers within it, if the strategies are sound, and if each responsibility center meets its objectives, the whole organization will achieve its goals." (Anthony, 1992, p. 127) It is the responsibility of top management to establish the right objectives for the different responsibility centers.

A budget is mainly a list of objectives. Usually different layers of management are involved in the process of preparing the budget. Some organizations use the budget process as an opportunity to allow information to flow in different directions in the organization: bottom-up, top-down and laterally. The result of the budgeting process is "a series of contracts between managers at each level of the organization, and between managers at that level and the next." (Ferris, 1987, pp. 50-54) Once the budget is established and the non-budgetary objectives are set, each sub-unit is then measured against these criteria.

Sub-unit managers are not expected to be interested in another sub-unit's performance or difficulties. It is expected that if each sub-unit achieves its goals, the whole organization will in-turn accomplish its goals. Most organizations realize that this view is overly simplistic because the sub-units are in fact inter-related. In order to overcome this problem, organizations use "transfer pricing" and other mechanisms to solve the inter-relational problems.

Another way management may ignore the influence of one unit on another is to measure a responsibility center only on one dimension of performance. As an example, a manufacturing unit may be measured only on the cost and quantity of production (a cost center) and not measured on how many products are sold. The sales force, on the other

hand, may be measured only by the quantity of sales (revenue center). By using these methods management can artificially treat each part of the organization as a separated entity.

A different area of management control is problem solving. The next assumption deals with problem solving.

d. If we know what the symptom is, we can easily identify the source of the problem.

Robert Anthony (Anthony, 1992, p. 4) defines the four elements of control as a detector or sensor, an assessor (for comparison with standards), an effector (feedback) and a communication network. The information sent by the detector is assessed by the assessor which provides feedback through the communication network. Information detected by the detector varies from one organization to the next but generally includes information such as return on investments, residual income, revenue, variances, cost, production, and customer complaints.

Management uses the information to compare the measured results to explicit and implicit objectives. A gap is usually perceived as a problem. For example, if the residual income of a business unit is significantly higher than budgeted residual income, it may imply that managers underestimated residual income. If the residual income is significantly lower than budgeted residual income, it may imply that the unit had some problems accomplishing its objectives. Measurements are constructed to detect gaps between the objectives and performance. Often, these

measurements are not detecting the problem but rather the symptoms.

Examples of sources and symptom of problems within an organization:

(1) Symptoms. ROI too low, cost too high, absenteeism too high, high employee turnover, a share price falls, debt ratio higher then intended, income too low.

(2) Sources of problems. Culture, barriers to communication, mental models, and variations in the input to a process.

Traditional management control system collects data about symptoms of problems. Once a symptom is detected, it is the management's responsibility to analyze the problem and to solve it. The process of analyzing the problem is done in different ways. However, traditional management control systems do not facilitate a formal systematic method to explore the source of a problem.

Because no systematic effort is undertaken to pinpoint causes of problems in an organization we can assume that managers, using traditional management control systems, believe that knowledge of the symptom will readily lead them to the source of a problem; otherwise, there would be some type of systematic method in place for locating sources of problems.

2. Mental Models regarding People:

a. *The best method to evaluate and motivate mangers is to measure their performance using quantitative standards.*

Traditional management uses the data collected by the Management Control System in different ways to motivate managers and workers: promotion, bonuses, wages, letters of appreciation etc. Performance measurements are also used as criteria for rewarding: a positive reward to those who are doing well and a negative reward to those who are doing poorly. Ferris writes that "a system to both motivate and control individual behavior is also needed" (Ferris 1992, p. 5). Measured performance is compared to goals set by top management.

Traditional management control systems acknowledge the complexity of quantitative measurement; individual goals must fit with the higher level goals and it is hard to compare different units of an organization. Thus subunit's goals must be congruent with the organization's goals and different subunits must be assigned different goals.

Goal congruence is a pervasive paradigm in traditional management control systems (Maciariello, 1984, p. 5). The set of goals a manager has to accomplish differs between companies, divisions, managers, responsibility centers, etc. But, management control systems must measure

the manager's performance by numerical criteria (Anthony, 1992, pp. 126-146).

Therefore, we see that in order to motivate and evaluate its employees and managers, an organization must compare their performances with numerical goals, and quantitative measurements facilitate such comparisons.

Management control systems are constrained to dealing with numbers, but not just financial numbers. The next mental model addresses these constraints.

b. ***There is a clear division of roles in an organization: top management plans and controls, middle management controls and line workers do.***

Traditional management control systems assume that there is a clear division of tasks in an organization. Top management does the thinking and they control the organization via middle management. Middle management controls lower levels and the line workers do the work.

No worker has the authority to change a procedure, no supervisor is involved in long term planning. Therefore workers, as are supervisors, are measured against a target. Higher managers participate in setting objectives on which they are measured. If the division of roles were not that clearly separated, then workers would take part in controlling and planning and middle managers would participate in long term planning.

3. Mental Model regarding Information:

a. *Most of the information essential to managing and controlling an organization can be gathered in the form of sub-unit and individual performance.*

The traditional management control system collects information about performance of the organization and its sub units. The data collected is used to direct the organization to achieve its goals and objectives.

Management control systems collect and process information from within the organization: financial performance, quantities, worker turnover, etc. And, this information does in fact describe the performance of individuals and sub-units within the organization.

Some organizations collect information about defective products and customer complaints. This information is used as well to evaluate the performance of individuals and sub-units.

These performance evaluations are used to determine whether the organization, subunits or individuals are doing as expected. Rewards or corrective activities are considered based on this information.

However, information concerning the processes, such as product variation or input quality and variation are usually not collected in traditional management control systems.

Like other organizations, military organizations have management control systems. A military has unique

characteristics that shape its management control system. In the next section we will discuss these characteristics and the military management control system.

C. MILITARY MANAGEMENT CONTROL SYSTEMS

This section is based our experience as officers in the US Navy and the Israeli Air Force.

Although, the military is a non-profit government service organization, like any other organization, the military has a management control system. A military spends most of its time preparing itself for its mission: exercising power through people systems and weapons in complex situations. The typical military management control system is based on a very structured chain of command, a well defined information network, and numerous measurements.

Three factors affect the military management control system. First, the ultimate purpose of any armed force is to fight. Second, the military is a government agency. Finally, the military does not have any competition in the private or public sector.

Since the military uses the same management control system in both peace and war, the management control system must first be appropriate for combat, the most extreme situation. In time of combat the goal of physical survival dominates. To allow for survival in dangerous environments, the network through which commands and information flows

must be simple and well structured. Although most of the military will never participate in a combat situation, the fighting unit's management control system will be reflected throughout the military.

Another factor that influences the military management control system (in a democratic society) and is also common to government organizations, is political intervention. Like every other government agency the military is subject to the close scrutiny of politicians, other government officials, and the media. These people are not necessarily experts in the areas in which they are scrutinizing. The political environment is very short-sighted; therefore, the military management control system must ensure that directives and guidelines aimed at the military are applied quickly and precisely as ordered.

The third factor relates to competition. The military does not have any competition with regards to its mission. No other government or private agency is competing to fight in Somalia, therefore, the military is not forced to change its management control system in order to become more competitive or to survive. Some elements of the military, like a DEPOT, do encounter partial competition. The lack of competitive pressure is balanced by political pressure. Pressure though, like a vector, has magnitude and direction. Political and competitive pressures do not have the same direction or magnitude.

Shaped by these three forces, the military has developed its own unique management control systems. Following is a description of a typical military control system in a democratic society.

The highest positions that control and manage the military are occupied by civilians who determine missions, strategies, acquisitions, wages, manpower and budgets. These decisions are a result of a political process over which the military does not have full control.

The military is measured by end results: Using all the budget (but nothing more), audits regarding handling money and inventory. In case of a combat the military is measured against its ultimate goal: to win the battle.

Rare are the occasions when a military gets a mission and is left alone to accomplish it. Usually top management, ie; secretary of defense or president, is watching every movement closely and interfering frequently. These patterns repeat whether the activity is systems acquisition, a combat mission, or womens' role in the military.

Lower levels management in the military hierarchy face a similar management control system. Upper levels of management set the strategies and goals. Middle managers, the officers and chiefs, have very little authority to change procedures, equipment, personal, or training in their units. Everything must be approved by a higher level of management. At every level, performance is heavily audited

and measured by quantitative criteria. The following are examples of measurements used by militaries:

- A US Navy ship may undergo thirty five external inspections in one year
- Gunnery results are measured and compared between units
- Physical training and physical fitness tests
- Mission readiness of equipment
- Fitness reports

A member in a military organization, unless he or she is in the very top, has a very little to say in determining long term plans and strategies. Each level gets a detailed set of goals and objectives from a higher level.

To make sure no one leaves the dictated trail, every level carefully examine its subordinates. If a unit gets slightly out of the tight constraint, it will be moved back promptly.

Militaries use positive and negative rewards to control and motivate their members. Positive rewards are in form of awards and promotion. Negative rewards are more common and more diversified: jail, money, relief from military, publicize poor performance and lower ranks.

The characteristics of a military control system described above are identical to a traditional management control system:

- Top management sets long and short term plans, vision, mission, and values
- Top management controls the organization through the hierarchy
- Middle management and employees have a very limited authority and control over thei units
- Incentives are used to control and motivate personal

D. CHAPTER SUMMARY

In this chapter we described traditional management control systems and some of the mental models upon which traditional management control systems are based. We also briefly described characteristics of military management control systems. Figure 3 visualizes the TMCS paradigm regarding management and control: the higher we are in the hierarchy the more control and the greater management authority we have over the organization.

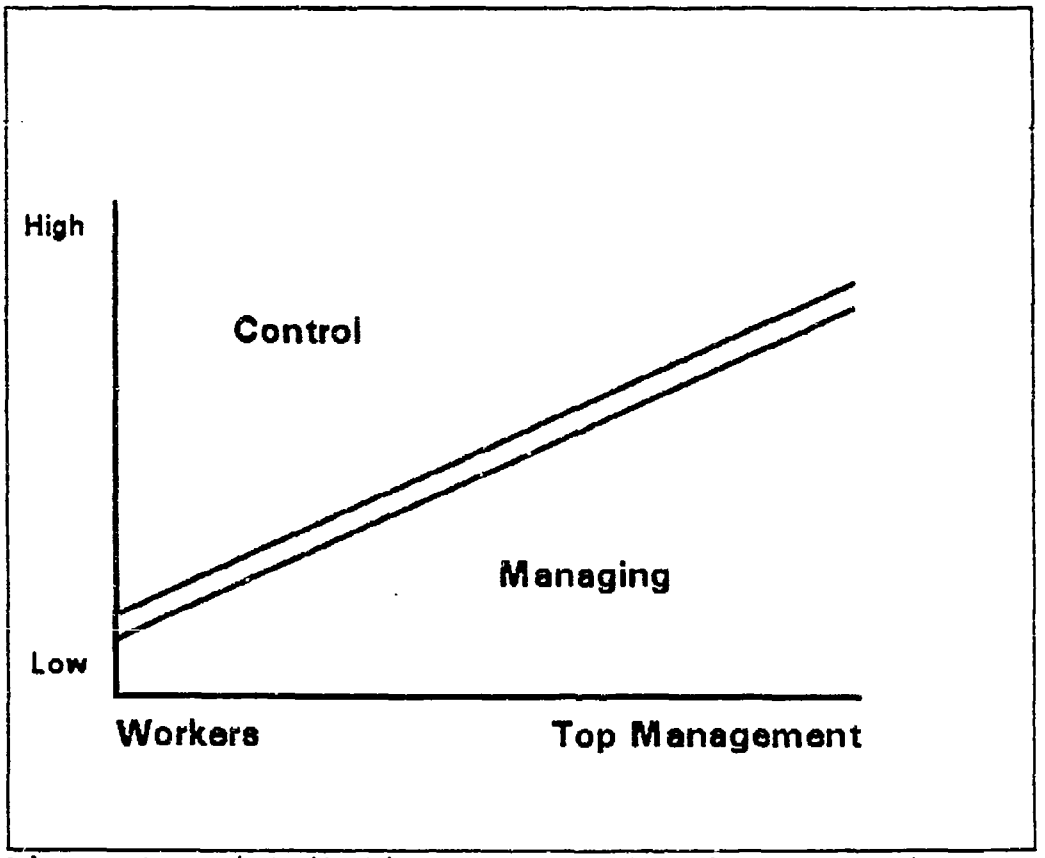

Figure 3. Distribution of Control and Management Authority in a Traditional Organization.

IV. FOUNDATIONS OF TOTAL QUALITY MANAGEMENT CONTROL SYSTEMS

Figure 4 illustrates a TQMCS (the elements in the large ellipse) and the foundations necessary for a TQMCS (the bricks on which the ellipse rest). One cannot hope to gain an understanding of the system without a solid grounding in the foundations upon which it rests. Therefore this section will discuss the various elements that create the foundations for the control system. The elements making up the actual TQMCS -- organization's cult re, the control system itself, management, and creators -- will be described in Chapter VII.

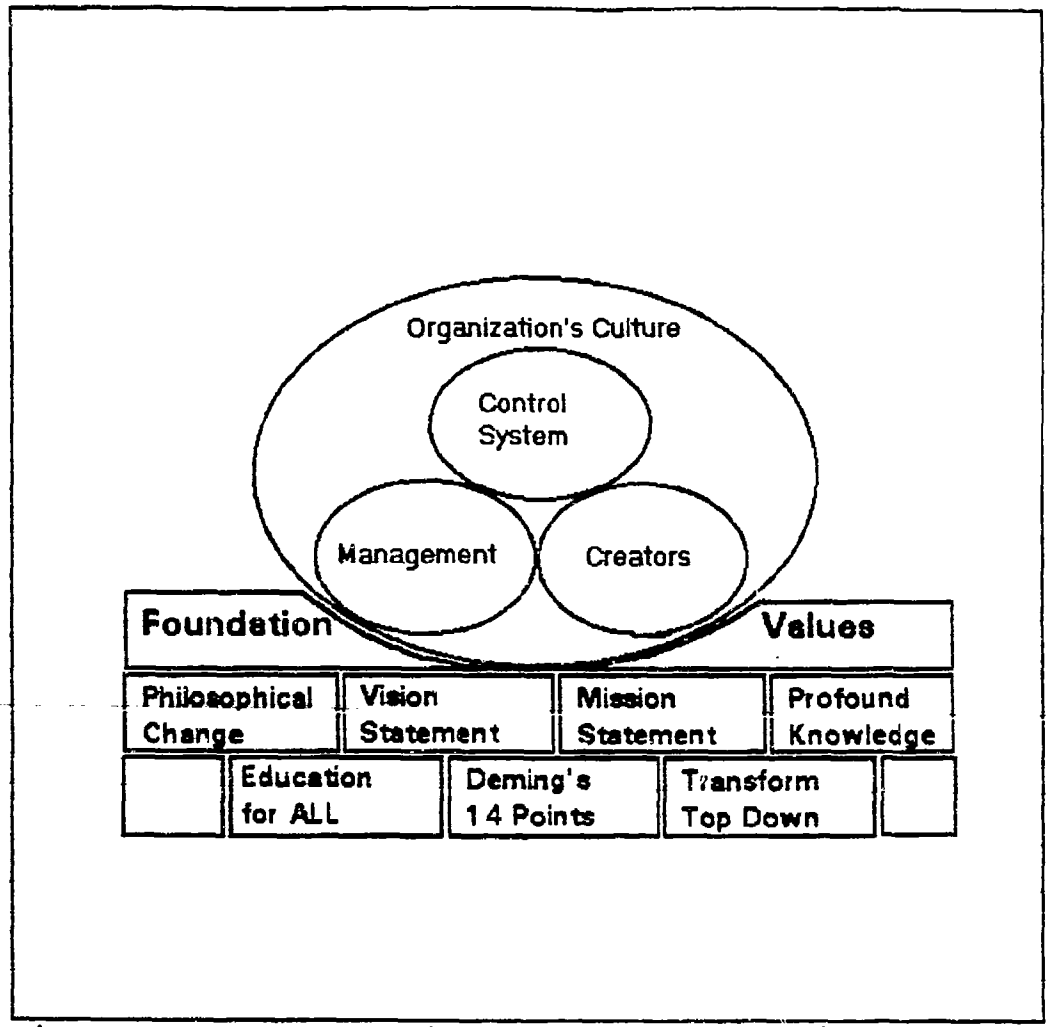

Figure 4. The Foundations for a Total Quality Management Control System Model.

A. A CHANGE IN PHILOSOPHY IS REQUIRED

First and foremost is the requirement for a philosophical change in the thought process of management. John Stewart Mill (1808-1873) once said, "no great improvements in the lot of mankind are possible until a great change takes place in the fundamental institution of their modes of thought" (Lippitt, 1973, p. 37). The same

can be said about transforming to a total quality management control system. Success requires a fundamental change in management philosophy. On adopting a new philosophy, Dr. Deming's second point states, "We are in a new economic age. Western management must awaken to the challenge, must learn their responsibilities, and take on leadership for change." (Deming, 1992, p. 82)

From Henri Fayol to Henry Ford, human resources have traditionally been viewed as mechanical arms and hands in someway connected to the manager who is the central processor for the whole system (organization) and that these resources should be maximized for gains in short-term profits (Deming's deadly disease number 2). If one of these mechanical hands malfunctioned, by becoming either under or over creative, the corrective measure was simple, you either fixed it or had it amputated, most often the latter. Total quality managers know and understand that their organization can, and in fact, does have <u>many</u> central processors who create and contribute to the long-term health of the organization. Total quality organizations have within them a constancy of purpose that allows each and every individual in the organization to contribute towards improvements in product and services, Deming's point number one.

B. THE VISION STATEMENT

According to Dr. Stephen Covey, "Most organizations face a real challenge in getting their people and culture united around a vision and strategy." (Covey, 1990, p. 143) A vision statement describes a desirable situation towards which an organization should strive. Once a vision is shared (not imposed but inspired by management) people in the organization will feel ownership for it. When people own the vision, they automatically direct themselves towards it, and do not need a manager to control them. Total quality management control systems emphasize shared vision as an important element (Senge, 1990, pp. 205,232).

C. THE MISSION STATEMENT

Closely linked with the development of the vision statement is the mission statement. An organization's mission statement states what business the organization is in. Vision and values are not normally a part of the mission statement, however, it is the combination of mission, vision, and values that creates unity and commitment within the organization. It gives people a frame of reference, a set of criteria or guidelines, by which they will govern themselves. They will not need someone else directing and controlling them for they will have bought into the changeless core of what the organization is all about. (Covey, 1990, p. 143)

The mission statement is vitally important to an organization's successful application of a total quality management control system. Without full involvement, there is no commitment. Mark it down, asterisk it, circle it, underline it. NO INVOLVEMENT, NO COMMITMENT (Covey, 1990, p. 143). A lack of commitment will result in a lack of constancy of purpose (Deming's deadly disease number 1).

A fully involved mission statement will also help prevent management mobility (or job hopping) in the corporate environment (Deming's deadly disease number 4) by removing ambiguities in what is expected of managers and creating in managers a feeling of belonging or ownership of the mission.

The organization's mission statement should be the hub of a great wheel. It should spawn the thoughtful, more specialized mission statements of sub-units and groups of creators (employees). The mission statement should be used as the criterion for every decision that is made in the organization. It will clarify corporate culture, how personnel relate to customers, and how they relate to each other. The organization's mission statement will effect the style of managers, how they recruit and train individuals, and the compensation system. Every aspect of the organization, essentially, is a function of the hub, the mission statement. (Covey, 1990, p. 142)

D. PROFOUND KNOWLEDGE

The third building block in the foundation is what Dr. Deming calls the System of Profound Knowledge. It consist of four interrelated parts: (Deming, 1986, p. 23)

- Appreciation for a System
- Knowledge about variation
- Theory of Knowledge
- Psychology

Figure 5 represents the four elements of Deming's system of profound knowledge. The shaded area covered by all circles represents Profound Knowledge (PK). One can only have PK if they have all four of the elements. Although Deming states eminence in each element is not required, he asserts that managers do need to possess some knowledge in each element.

The system of profound knowledge is an important building block for a TQMCS because of the transformational nature of the total quality journey. Tichy and DeVanna relate this transformation to a three act play. Act One is Recognizing the Need for Revitalization. In this act the drama centers on the challenges the leader encounters when he or she attempts to alert the organization to growing threats from the environment. Act Two is Creating a New Vision. This involves the leader's struggle to focus the organization's attention on a vision of the future that is exciting and positive. (See the beginning of this section for a discussion of vision as a part of the foundation for a TQMCS.) Act Three is Institutionalizing Change. Here the

leader seeks to institutionalize the transformation so it will survive his or her tenure. (Tichy, 1990, p. 7) In the transformation to total quality, profound knowledge is the leader's guide. An interesting point to note is that Deming states that profound knowledge must come from the outside and by invitation (Deming, 1992, p. 61). This implies that a TQMCS must incorporate external information to be effective.

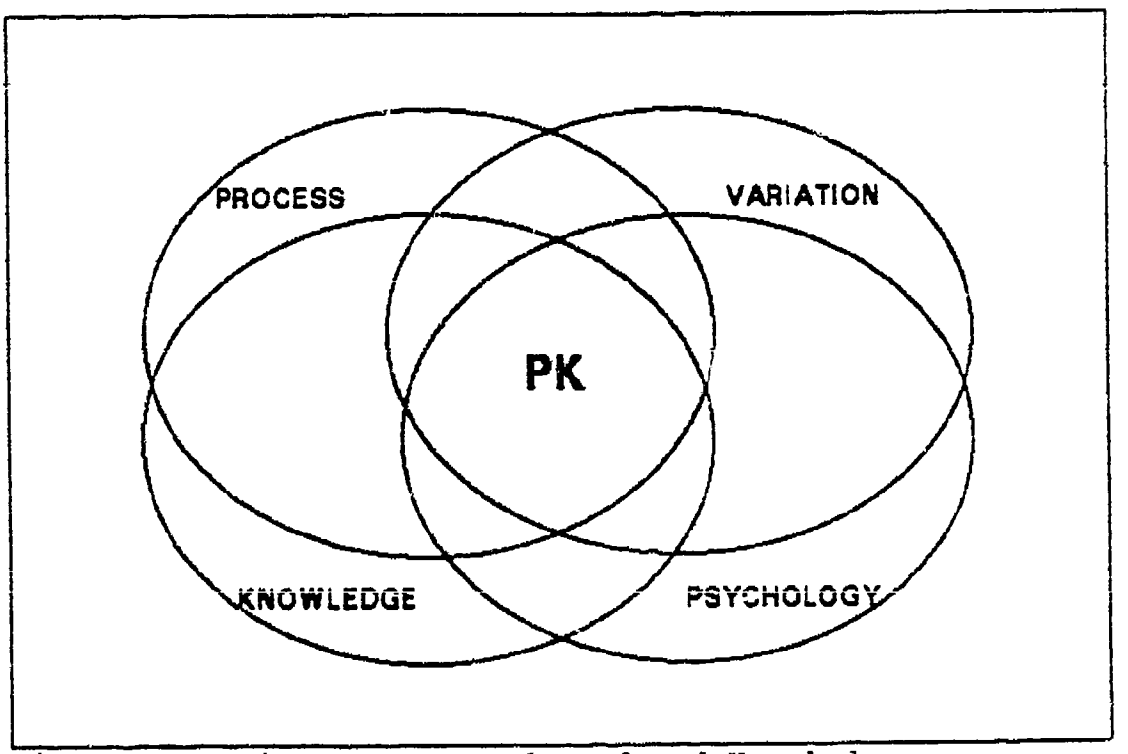

Figure 5. Deming's System of Profound Knowledge

1. Appreciation of the System

Before one can appreciate a system they must first understand it. If a picture is worth a thousand words then a flow chart must be worth a million towards understanding the interconnected complex of functionally related components that make up any system (See example in Figure 6). Management of a system requires knowledge of these inter-relationships as well as the people that work in the system. In the total quality approach a flow diagram provides this requisite knowledge. (Deming, 1992, pp. 62,63)

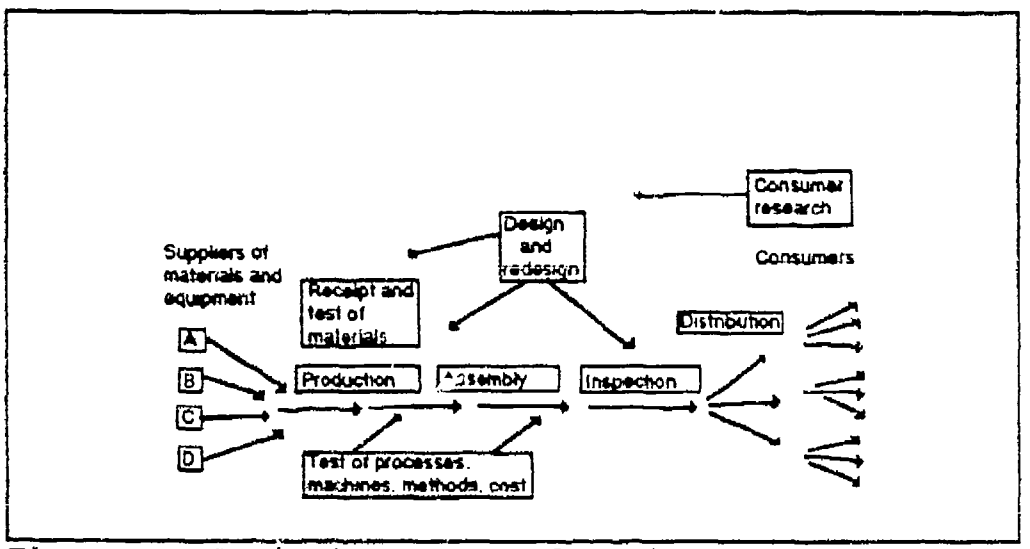

Figure 6. Deming's Systems Flow Diagram.

2. Knowledge of Variation

Knowledge about variation is crucial to Deming's system of profound knowledge and is intertwined with the elements of appreciation for a system. By studying the

variation that exists in the system, managers know when and how to improve processes to optimize their system. Two portions of knowledge of variation are particularly important to a TQMCS: understanding the difference between special and common causes of variation and understanding the concept of the Taguchi Loss Function. Managers with a thorough knowledge of the two types of variation ensure the right actions are taken to improve the system. Those with knowledge of the Taguchi Loss Function understand that management control systems must do more than just ensure everything meets specifications.

3. **Theory of Knowledge**

The theory of knowledge helps one to understand that management in any form is prediction. (Deming, 1992, p. 69) Managers can know the past with certainty, however, any knowledge of the future can only be a prediction. All managers would like to make rational predictions. But this can only happen if their predictions are based on a theory that has been developed through knowledge of the past. By reviewing and analyzing both long-term and short-term actions, making comparisons and using planned experimentation, managers can, with greater accuracy, predict future outcomes.

4. **Psychology**

Psychology helps us to understand people, interaction between people and circumstances, interaction

between customers and suppliers, interaction between teacher and pupil, and interaction between a manager and his people and the system of management. (Deming, 1992, p. 73) All individuals have differences in their traits, attitudes, and capabilities. A good manager will know the differences in his people's traits, attitudes, and capabilities and armed with this knowledge, be able to optimize each person's abilities and inclinations.

E. EDUCATION

An organization that is making the transformation to a quality focused culture will encourage education and self-improvement for everyone (Deming's point 13).

Many corporations in western economies face a tremendous amount of competition. Most product-lines either have many competitors or have very low barriers to entry into the production of that product. Non-profit organizations, such as the military, are also besieged by competition. Granted, much of what the military does will remain firmly under the control of the military. However, as budgets continue to shrink, fierce competition for the available dollars and a need to get the most "bang for the buck" will result in inter-departmental rivalries within Government and particularly DOD. Ultimately, only those organizations that are the most efficient will emerge as victors.

Efficiency is a product of knowledge. Henry Ford's first model "T" was grossly inefficient as compared to the Ford Taurus. Getting from the model "T" to the Taurus involved progressively building on existing knowledge. Therefore, what an organization needs is not just good people; it needs people who are improving with education. (Deming, 1986, p. 86)

F. IMPLEMENTING DEMING'S 14 POINTS

The 14 points, see Table 1, are a corner stone for transforming America's industry and non-profit organizations, such as the military. Adoption of the 14 points will aid the organization in obtaining and maintaining acceptable level of efficiency by avoiding problems in the organization. It will not suffice merely to solve problems, big or little. Adoption and action on the 14 points are also a signal that management intends to stay in business and aims to protect investors, jobs, and conserve scarce budget dollars. The 14 points can be applied anywhere, to small organizations as well as to large ones, to service industries as well as manufacturing, and they can apply to a sub-division of an organization. (Deming, 1986, p. 23)

TABLE 1. DEMING'S 14 POINTS. (Deming, 1986, p. 23)

1.	Create constancy of purpose for improvement of product and service.
2.	Adopt the new philosophy.
3.	Cease dependance on mass inspection.
4.	End the practice of awarding business on price tag alone.
5.	Improve constantly and forever the system of production and service.
6.	Institute training.
7.	Institute leadership.
8.	Drive out fear.
9.	Break down barriers between staff areas.
10.	Eliminate slogans, exhortations and targets for the work force.
11.	Eliminate numerical quotas.
12.	Remove barriers to pride of workmanship.
13.	Institute a vigorous program of education and retraining.
14.	Take action to accomplish the transformation.

G. TRANSFORMATION IS TOP DOWN

Organizations that are in the process of or have adopted TQ could have only done so by transforming themselves. Unfortunately, transformations are not something that "just happen." For a transformation to occur there must be a leader. "The transformation is top down." (Deming, 1992, p. 82) Therefore, we must search for transforming leadership that "ultimately becomes moral in that it raises the level of human conduct and ethical

aspirations of both leader and led, and thus it has a transforming effect on both." (Burns, 1978, p. 20)

While entrepreneurs can start with a clean slate, Transformational leaders must begin with what is already in place. (Tichy, 1990, p. 4) Before a leader begins to transform an organization, he, or she, should seriously examine their own motives. The transforming leader of today is similar to the legendary phoenix. The phoenix could regenerate itself but only after it had been destroyed. The transforming leader must, in a sense, destroy his, or her, old leadership style. Doing this requires a leap of faith. This leap of faith that destruction w 'l result in rebirth is tied to the tension between stability and change and countered by the denial that change is necessary." (Tichy, 1990, p. 28)

V. THE CANON MANAGEMENT CONTROL SYSTEM

As previously discussed, the purpose of any control system is to achieve organizational objectives. The total quality management control system is no exception.

This and the following chapter examine two of the many models for a TQMCS; the Canon Production System model, and the GOAL/QPC model. The best elements of each model will be used to construct a generic model of a total quality management control system adaptable to most management situations.

A. BACKGROUND

Canon corporation is a manufacturer of high quality cameras and copy machines. As a result of Canon's going into the red in 1975 after many decades of success and profits, management began to move away from its traditional highly centralized, top-down management control system and towards a management control system that delegated greater decision making to line managers, sales and service personnel, and gave greater weight to the intuitive quality and personal touch of the "hands-on" type of management (JMA 1987, p. vi). Canon's managing director, President Ryuzaburo Kaku, proposed a plan designed to make Canon a world-class corporation within six years. The birth of the

Canon's new style of management control system is known in Canon as the "Canon Production System."

Canon's vision is to be a world-class or premier corporation. Its company wide goals are:

- Strive for the best quality
- The lowest cost
- Fastest delivery anywhere

These goals are achieved by pursuing three basic strategies.

- Reliable quality assurance
- Efficient production methods
- Development of human resources

Human resource development has traditionally been a fundamental element of Canon's corporate culture. (JMA, 1987, p. 8) There are four guiding principles applied by Canon in the development of human resources:

- Merit based promotion
- Family (or team) spirit
- Health (mind and body)
- "Three Selfs" (self-motivation, self-respect, self-reliance) (JMA, 1987, p. 9)

Even by Japanese standards Canon is a revolutionary company, but more importantly, Canon is an evolutionary company. Canon's culture is one of constant and continuing improvement.

B. CANON'S MENTAL MODELS REGARDING MANAGEMENT CONTROL

1. Mental Models regarding Planning and Problem Solving

a. Understanding and eliminating waste is the key strategy for permanent corporate improvement

Canon recognized that a decline in corporate achievement can usually be traced to internal inefficiencies that prevent the company from responding to change, and focuses on eliminating waste from manufacturing and indirect operations. By 1983, Canon's profits from eliminated waste totalled $450 million. (JMA, 1987, Chapter II)

b. Over-production is the most complex and challenging form of waste, therefore, it is important to focus on reducing work-in-progress.

Cost reduction necessitates that all forms of waste be quantified and measured. After management and employees became accustomed to viewing all waste as measurable, it is obvious that over-production is the greatest form of waste and that it creates, sustains, and hides many other forms of waste. Reducing work-in-progress, however, provides solutions to many other problems. It promotes a work environment where human resources can be fully developed and used. (JMA, 1987, Chapter VIII)

c. Absolute dedication to defect detection and prevention at their source

Each and every employee at Canon is committed to following established standards and procedures regarding detecting defects at their source and takes immediate action whenever problems occur. Canon has integrated improvement

activities into daily work with the aim of preventing quality defects at their source. (JMA, 1987, Chapter IX)

d. Adding value through waste reduction is Canon's fundamental strategy for continuing improvement

Eliminating waste reduces cost and adds value to products without capital investment, thereby increasing the company's profit margin. Product improvement is achieved through value engineering. All improvement activities at Canon are dedicated to reducing waste and thus reducing cost. (JMA, 1987, Chapter X)

e. Effective planning brings people together to achieve results

Resources in and of themselves are useless without a process that flows smoothly toward clear-cut objectives. Canon has harnessed and systematized cooperation by giving people goals to strive for and reliable methods assist their progress, and has reaped the rewards of fostering individual responsibility, self-development, and higher quality teamwork. (JMA, 1987, Chapter V)

f. Concentrating improvement efforts in the smallest production unit will yield the biggest results

Canon's Production System goals are actually achieved through production in the smallest unit, the workcenter. Workcenters are empowered to pursue continual improvement. Canon management firmly believes in the contribution of the workcenter. (JMA, 1987, Chapter III)

g. Continuous improvement is the result of continuous involvement

At Canon, improvement is not viewed "extra" effort, but rather, the "habit" of improvement is an integral part of everyone's daily work. (JMA, 1987, Chapter VI)

2. Mental Model regarding People

a. Give people training they can use, to do work that is personally challenging and important to the company

Training promotes continuing improvement and successful goal achievement by giving people the tools and methods they need. (JMA, 1987, Chapter VII)

3. Mental Model regarding Information

a. Managing improvement means sharing information

Continual improvement translates to change and growth. For an organization to have both growth and change, it must also have thorough and continuous sharing of information. Shared information must be concrete, objective, and sufficiently detailed to promote growth. It must also be open and blame-free if it is to break down resistance to change. (JMA, 1987, Chapter IV)

C. CANON'S MANAGEMENT CONTROL SYSTEM

1. Overview of the Structure

Canon's Production System (CPS) is sustained by a system of pillars, see Figure 7 (JMA, 1987, pp. 30-31). These pillars are:

- Level-by-level improvement targets
- A line centered production system that is primarily concerned with Canon's three goals which are quality, cost, and delivery time
- A staff centered support system that is concerned with supporting the line effort with new production technologies and management techniques
- The workplace vitalization program which promotes continuous improvement through structured group involvement and activities within the workcenter

Each of these pillars is described in the following sections.

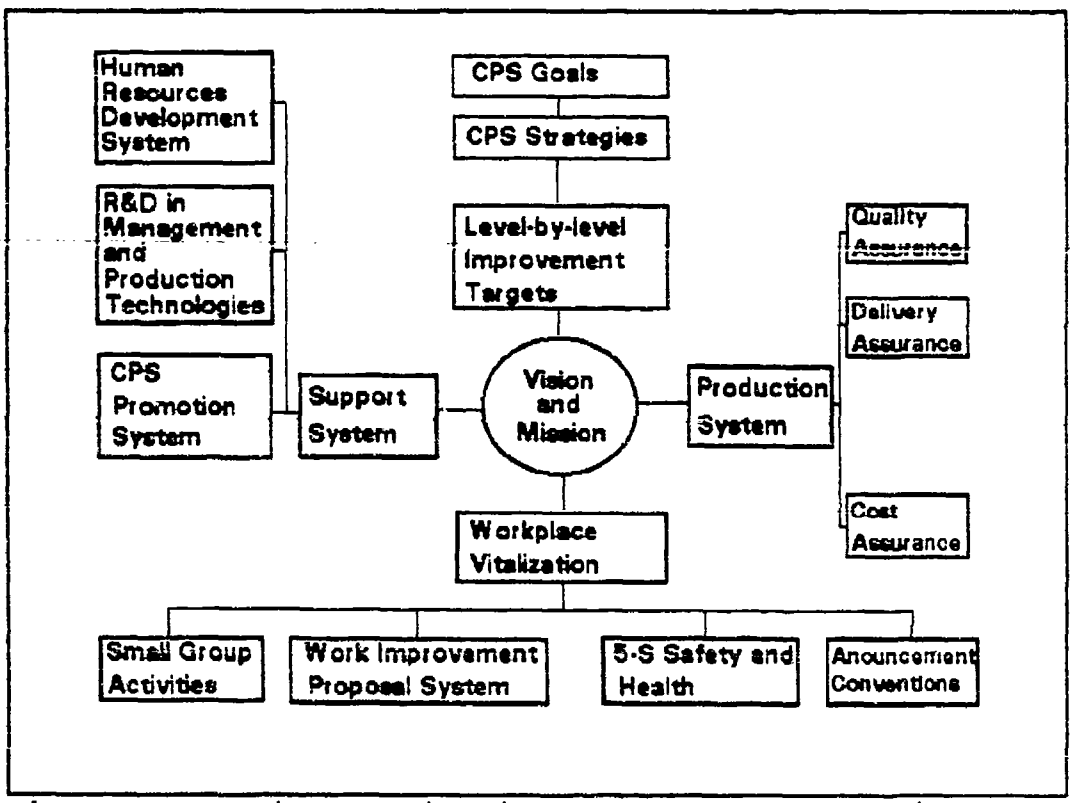

Figure 7. Basic Organization of Canon's Production System. (JMA, 1987, Figure 3-1)

2. Level-by-Level Improvement Targets

Level-by-level improvement targets are a direct outflow of Canon's Production System Goals and Strategies

which are set by management. These level-by-level targets assign functions and goals to each level in the organization (JMA, 1987, p. 31). Canon's matrix management system, see Figure 8, allows Canon to make these long range plans while maintaining the flexibility to react to unforeseen market changes and is just one of many keys to Canon's success. The matrix is structured with product groups forming the vertical axis and committees acting as investigative bodies forming the horizontal axis. This matrix management system provides for more support and less control from central offices (JMA, 1987, p. 8).

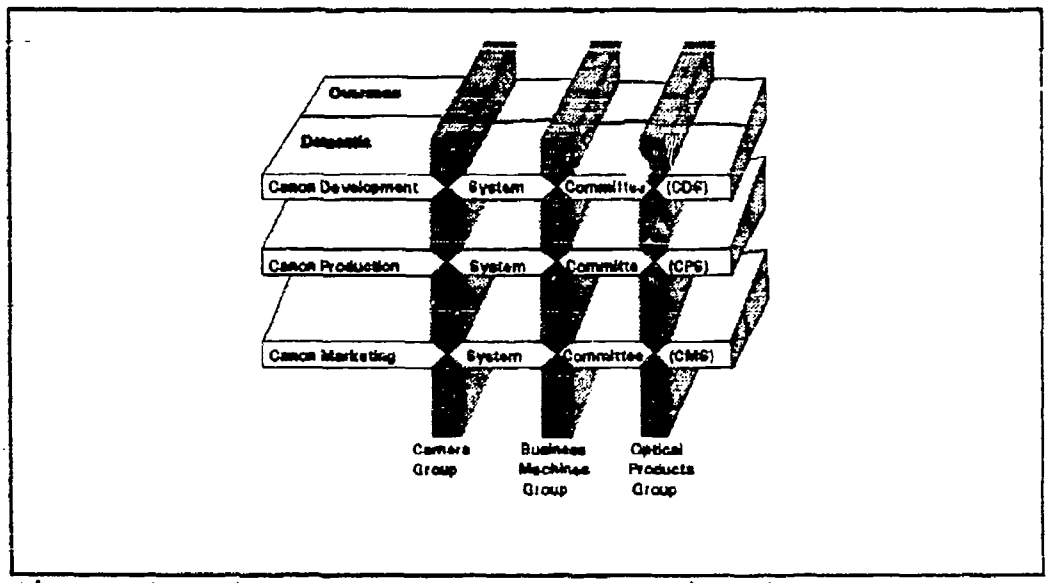

Figure 8. The Canon Management Matrix. (JMA, 1987, Figure 1-2)

3. Production System

The Basic Production System is composed of three separate sub-systems, quality assurance, delivery assurance,

and cost assurance. The quality assurance system uses QA flow charts, standardization, and process improvement activities to build quality in at each and every step. The delivery assurance system uses HIT (just-in-time) inventory principles to achieve shorter manufacturing times, quicker response to product changes, and faster delivery times. The cost assurance system reduces cost through team activities, value engineering, efficient contracts with suppliers and productivity improvements in the manufacturing process. (JMA, 1987, Chapter III)

4. Support System

The Support System is a cross functional system that operates at every level in the organization. It also consists of three separate subsystems:

- The Human Resources Development System
- The Research and Development in Management and Production Technologies System
- The Canon Production System Promotion System

The Human Resources Development System is a training program that provides Canon's human resources with skill broadening and management and specialty training. The Research and Development in Management and Production Technologies System provides for a variety of special and company wide projects. The Promotion System is charged with maintaining the merit awards system, special functions, and various Canon Production System activities. (JMA, 1987, Chapter III)

5. Workplace Vitalization

Canon's thrust for continual improvement begins in the workplace or workcenter. Mr. Kaku, firmly believes that building a world-class company necessitates building a world-class workcenter. Canon's Production System goals are actually achieved through production at the smallest unit which is the workcenter (JMA, 1987, p. 32). The Workplace Vitalization Program encompasses various post-Canon Production System efforts that center around zero defects and clean working spaces. These efforts are organized into small group activities and continue to promote continuous improvement through the work improvement proposal system and the health and safety system. (JMA, 1987, pp. 31-32)

Each and every one of Canon's workcenters are created around the following elements: the workcenter and all the creators in it will have a common purpose; information that is monitored by the workcenter, such as waste and quality indicators, will be pictorially represented on control charts that reflect reality as well as ideal results; workcenters have weekly goals and plans that reflect the shared ideas of both creators and manager; each task in the plan will have a responsible person assigned; all members of the workcenter participate within the framework of the "three selfs"; All information such as target figures and status charts will be shared by all; control charts and graphs are studied for indicators that reflect potential

waste or inefficiencies; and finally, the original plan for the workcenter is evaluated periodically to ensure that the system is working towards the proper goals and objectives. (JMA, 1987, p. 33) A profile of a Canon workcenter is one of consistency in the following areas:

- High achievement
- Development of human resources
- Operations are continually improving and eliminating waste
- Individual objectives and goals are clear
- Everyone sticks to the strategy
- Progress is pictorially represented for all to see
- Information is freely shared (JMA, 1987, p. 32)

6. Tools used in Canon's MCS

Canon's Management Control System utilizes the following tools for accomplishing its goals and objectives:

a. Doctors Rounds

Top management makes "house calls" at periodic intervals to each sub-unit of the organization. During these visits, the sub-unit manager reports on the continuing improvement effort, goal achievement plans, current savings from waste elimination, and counter measures used for specific problems. The visiting manager may comment on a proposed solution, suggest new approaches in an area where little progress has been made, or point out a problem that has not been noticed by factory management. (JMA, 1987, pp. 49-50)

b. Catch Ball

Whereas doctors rounds provide a formal setting for talks with management and sub-unit managers, catch ball brings together section managers to play "catch" with ideas and problems experienced by either one or all. (JMA, 1987, pp. 50-51) For example, strategies initiated at the top are sent down in the organization for consideration and suggestions. These strategies are then sent back up with proposed changes and recommendations. Management considers these recommendations, modifies them, and sends them back down. This process will continue until a consensus is reached.

c. "Built-in" Emphasis on Planning

Plan first then act is the general rule for all Canon Production System operations. Canon's planning system incorporates a broad three year plan and an annual goal achievement plan. Two primary objectives in planning are precision in planning and greater reliability in execution of plans. Because planning is an automatic activity in the Canon Production System, the annual plan has become a model of precision and effectiveness. Canon has four guidelines for planning:

- The purpose of planning is to help reach the target
- Before developing a plan, identify the concrete steps to be taken and document the feasibility of every proposed improvement
- Before implementing an improvement, estimate and evaluate the expected results
- Keep everyone informed through visual control

This means every final plan must be formally announced and posted. All employees are taught the importance of planning and are given plenty of opportunities to practice the plan-execute-plan-execute cycle. (JMA, 1987, pp. 53-55)

d. Self-Management

Self-management activities practiced by Canon employees have the by-product of improving the skills of supervisors or managers. Because managers must pay closer attention to the worker in order to help him or her identify the worker's own area of concern, they find they pay closer attention to improving their own management skills. Self-management activities at Canon promote individual skill development and responsibility within the context of team efforts for improvement. Self-management is also a primary contributor to waste elimination goals. (JMA, 1987, p. 57)

e. Mutual Analysis and Counseling

Canon's Production System is dependent on both small groups at the worker level and project centered group activities at the foreman level and above. These groups use a group activity process illustrated in Figure 9 to set new targets. Small groups are self-regulated and consist of three or more workers or managers. Everyone in the organization will belong to at least one small group. The purpose of the small groups are to increase profits for the corporation, skill levels for the individual, and to instill

a feeling that the work is worth doing. In the project-centered groups, a cross section of plant managers and supervisors reviews problems from one department and investigates opportunities to make improvements. On the basis of advice and counsel received from the project-centered group, the managers and supervisors in that department then carry out the improvements. These practices are so widely accepted that, as a rule, Canon employees routinely tour the work space and write up thei. own observations on a "mutual analysis and counsel sheet." (JMA, 1987, pp. 81-89)

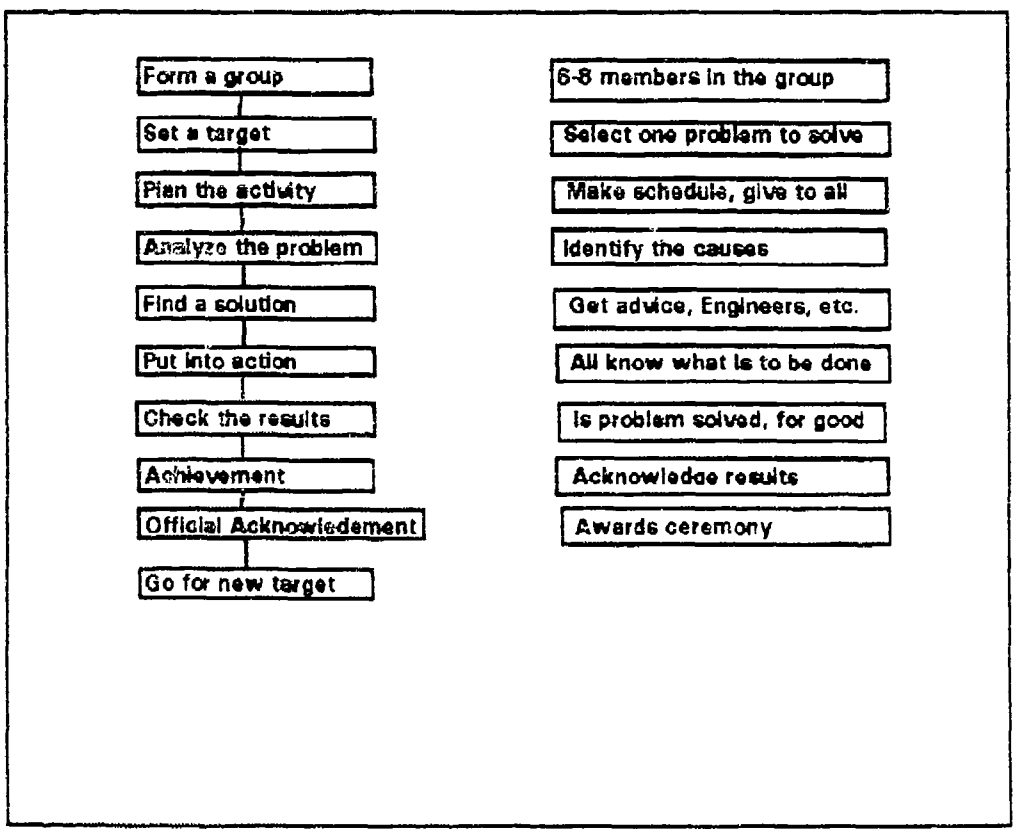

Figure 9. Canon's Group Activity Process. (JMA, 1987, Figure 6-5)

f. Awards System

Canon's award system rewards people who work hard and produce excellent results. Each year Canon gives out eleven types of awards for superior achievement, records keeping, waste elimination, and Group activities, etc. The highest award is the Premier Workcenter Prize, given to the workcenter practicing the most outstanding day-to-day management and waste elimination methods. All awards are based on continuing process improvement and focus on team effort. Promotions at Canon are not part of any system of awards; they just happen. Employees pretty much know who will be promoted and when. Those that work the hardest and show the most ability are usually the ones promoted. (JMA, 1987, pp. 95-97)

g. Training Program

Training is conducted at Canon to accomplish three objectives; promoting the Canon Production System, supporting annual goal achievement, and raising the skill level of human resources. Improvement techniques discovered in one workcenter are made available to other workcenters, requiring that courses in Canon Production System basic operations be continuously taught. The essential team approach is emphasized in every Canon training program because company-wide team work is essential to achieving results. Although it may appear less efficient, all of Canon's policies and procedures are established

collectively. This means that the skills and abilities of each and every employees must continually be developed. Training is seen as an opportunity for self-development. Methods and tools derived from these training sessions provide management and employees with a common language to use in planning productivity improvement. (JMA, 1987, pp. 103-106)

h. HIT System

HIT is an acronym that in Japanese means "what is needed, when and in the amount needed, and make." HIT is Canon's version of a just-in-time production system. Using the Toyota Kanban system as a model, Canon combines a continuous flow system with their approach to process control and work management. Continuous flow is promoted through systematization, small lot size, load leveling, and pull-by-subsequent-process. Systematization arranges processes so that a part can be processed and assembled in a single sequence with as little delay or distance between processes as possible. Work centers are organized to correspond with the flow of the manufacturing process. Small lot size shortens setup time to make frequent changeovers feasible and small lot production economical. Load leveling averages production volume and variety to reduce fluctuations in process load (smoothing production). Pull-by-subsequent-process draws parts from the previous process only when needed and only in the amount needed.

These changes have reduced work-in-process, inventories, and cost. (JMA, 1987, pp. 117-166)

i. Quality Assurance (QA)

The QA system at Canon spans all departments. The system gives each department a role in quality assurance and establishes reporting channels to ensure effective implementation and adherence to standards. Achieving quality means focusing improvement at the source of the defect. Prevention is the most important role of QA at Canon. Preventing the defect before it occurs is a major contributor to eliminating waste. The QA system at Canon is heavily dependent on Quality Assurance Flow Charts. Flow charts are a tool designed to promote quality from the earliest stage of production. These QA flow charts essentially break down the manufacturing process into detailed quality characteristics for individual components and are expressed in the form of values. Quality standards and checking procedures are established through flow charts. Inspections are used to ensure these charts are used effectively. The QA inspection answers three important questions:

- Are established procedures followed?
- Are measurements taken to prevent recurring defects?
- Are standards revised once improvements have been made?

These inspections are conducted in the following four areas; work standards, QA flow charts, measured values control, and measuring instruments control. Inspections are conducted

using a checklist developed for the respective process. (JMA, 1987, pp. 197-217)

j. TSS (Japanese - stop line, now, correct problem)

Stopping the line is discouraged in the traditional management control system but at Canon TSS gives the worker the authority to stop the production line in order to pinpoint and eliminate problems. Stopping the line is not the ultimate goal of TSS. But stopping the line now to eliminate problems will prevent the line from having to be stopped in the future. Whenever work can not be done according to work standards or production requirements, the worker stops the line, corrective action is taken and the line is restarted. (JMA, 1987, pp. 169-190)

k. Consulting system for suppliers

Outside suppliers furnish seventy to eighty percent of all parts used by Canon. Hence, quality of outside-supplier parts determine the quality of Canon products. For this reason it is very important that Canon select suppliers that will cooperate with Canon's quality effort. Canon's quality assurance personnel work closely with suppliers and make available the improvement methods and quality management techniques developed by Canon. Canon holds a preliminary consultation with suppliers selected as cooperating suppliers. The following items related to quality are thoroughly discussed and agreed upon:

- Function and demanded quality of the product
- Use and adjustment of measuring instruments and jigs
- Methods for gathering quality data
- Acceptance testing standards

- Handling and packaging
- Persons to contact in case of problems

Additionally, Canon personnel provide assistance in the use of statistical methods, controls, and improvement techniques in regularly scheduled discussions or visits to the supplier. Suppliers that develop a solid quality assurance system and score high consistently in acceptance test of supplied material are given special recognition. (JMA, 1987, pp. 191-195)

1. Value Engineering (VE)

The objective of VE is to ensure that cost-reduction and cost-control procedures are built into development and production rather than added on an ad hoc basis. In VE, an interdisciplinary team measures the current value of a product or its components in terms of functions that fulfill user needs or objectives. The team then develops and evaluates alternatives that might eliminate or improve component areas of low value and matches these alternatives with the best methods for accomplishing them. (JMA, 1987, pp. 197-215)

VI. GOAL/QPC MANAGEMENT CONTROL SYSTEM MODEL

A. GOAL/QPC'S MANAGEMENT CONTROL SYSTEM

1. Overview of the Structure

The GOAL/QPC model, is reflective of a wheel with the customer being the focal point or hub of that wheel, see Figure 10. This wheel is the mechanism whereby the organization watches for upcoming threats and opportunities and avoids being blind-sided. The model allows the organization to do the routine well, as well as create continuous improvements in systems, processes, and products and services. (Brocka, 1992, pp. 122-123) Each element of the model will be explained in subsequent sections.

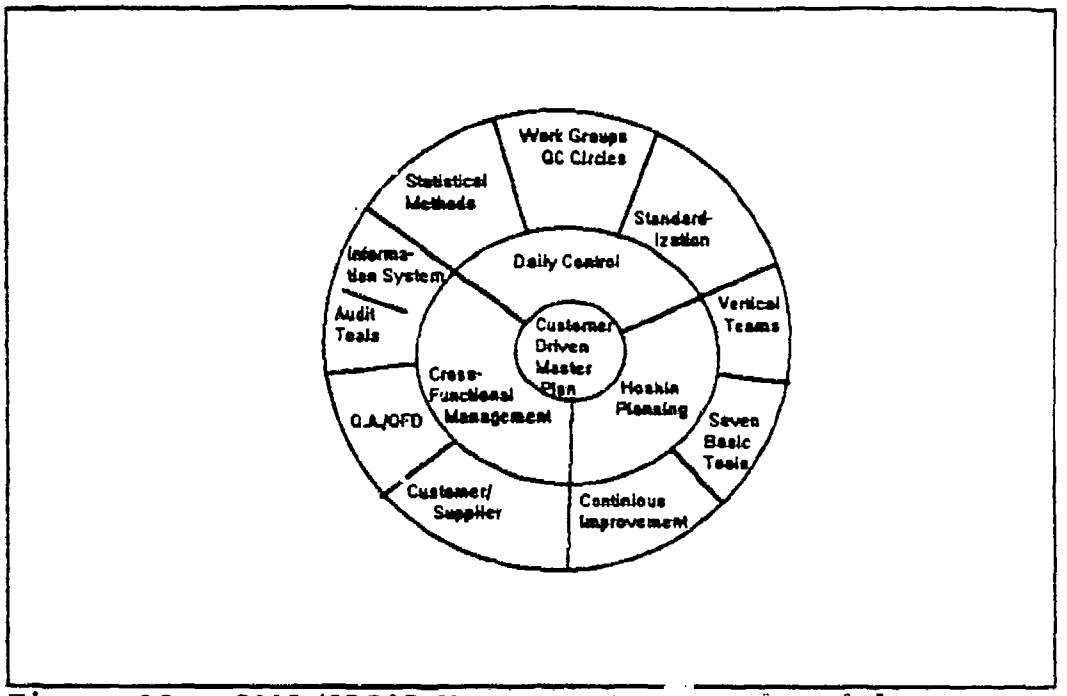

Figure 10. GOAL/QPC'S Management Control Model. (GOAL/QPC, 1989, Figure 1.4)

2. Customer-Driven Master Plan

Reflecting the importance of the customer to total quality, the GOAL/QPC model is customer driven. The customer driven master plan is the hub of all other management control activities and is designed to accurately forecast customers' needs, the actions necessary to meet those meet or exceed those needs out five to ten years. Additionally, the master plan includes other actions necessary during the same five to ten years for the organization to transform itself to total quality. (King, 1989, pp. 1-10; 2-3)

3. Daily Control

Daily control is defined as each employee knowing what is required of them on a daily bases for the organization to run smoothly and efficiently. Daily controls must be simple and clear. As the model illustrates, tools used to support daily controls are:

- Statistical Methods
- Working Groups/Quality Circles
- Standardization

a. *Statistical Methods.*

Statistical methods help people make decisions based on facts and to understand and control variation. Statistical tools are needed for general and intermediate planning, problem solving, and understanding and controlling variation. (King, 1989, Chapter I) Some tools are more useful in the planning stage while others are invaluable in the in-process phase. The seven tools (Figure 11) are:

- Flow Charts
- Pareto Charts
- Cause and Effect Diagrams
- Run Charts
- Control Charts
- Scatter Diagrams
- Histograms

For further discussion of these tools the reader is referred to Appendix A.

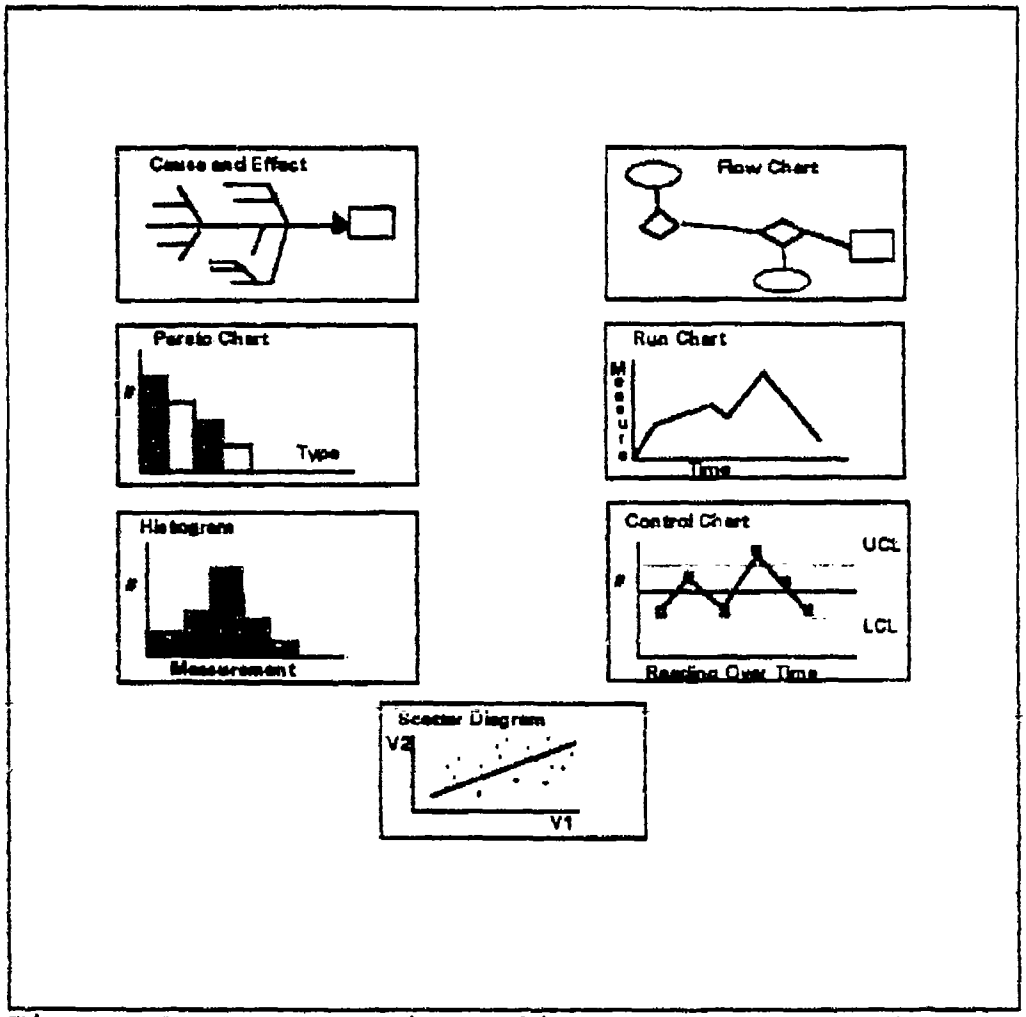

Figure 11. Seven Basic Quality Measurement Tools. (Walton, 1991, p. 23)

b. Work Groups/QC Circles.

In the arena of daily control work groups and quality circles foster the team approach to problem solving and provide an environment in which people get together to work on problems and continuously improve their processes. (King, 1989, p. 1-10)

c. Standardization.

Simple and clear written instructions that are used on a regular basis and up-dated when improvements are made, aid the employee in working effectively and efficiently. (King, 1989, p. 1-10)

4. Hoshin Planning

Hoshin planning is one of the three majors systems in the GOAL/QPC model. Hoshin planning helps to control the direction of the organization by orchestrating the change taking place in the organization. The key to Hoshin planning is that it brings the whole organization into the strategic planning process by aligning itself top to bottom (vertical alignment) around what is important. "Catch ball" (see Canon model, Chapter V) is just one tool used to create this alignment. (King, 1989, Glossary)

Another way to view Hoshin planning is to equate it to using a road map to plan a trip. If you properly plan your trip and use your road map, you will arrive at your desired destination. If an organization properly plans its direction and destination and uses Hoshin (the map), it also will arrive at its desired destination or vision. Hoshin planning is a vehicle or means for continuous improvement.

a. Continuous Improvement.

Continuous improvement requires that the organization continually think of ways to do things better, implement better ideas, and acquire the habit of continuous

improvement. (King, 1989, p. 1-11) Hoshin planning focuses the energy of the entire organization on long-term competitiveness and ultimately the survival of the organization. To accomplish this, everyone in the organization must work together on a never-ending cycle of process standardization, continuous improvement, and re-standardization of the process. The end result of the continuous improvement process is major improvements in areas of critical importance; such as the quality, timeliness, and value of the product delivered to the customer. (Moran, 1991, pp. vi, vii)

b. Vertical Teams.

Vertical teams consist of customers, suppliers, creators, and management. Individual team members will have specific knowledge of the process for their area of responsibility. Therefore, a vertical team is more likely to have all the necessary information to make decisions. The GOAL/QPC model uses vertical teams for planning and problem solving. Tools that will be used by these teams are the seven management tools. (King, 1989, p. 1-11)

5. Cross-Functional Management

Cross-Functional Management is another element of the GOAL/QPC model. While Hoshin planning is primarily a vertical activity, cross-functional management focuses on the horizontal activities of the organization. It also is used in such a way that all aspects of the organization are

well managed and have consistent, integrated quality efforts pertaining to scheduling, planning, etc. (King, 1989, Glossary)

a. Quality Assurance/Quality Functional Deployment (QA/QFD)

The QA system is a tool used for controlling quality horizontally throughout the organization. QFD is a tool used to find out what the customer wants and to get that information to the right people in the organization. The two tools work together to allow an organization to identify customer needs and translate them into product design and ongoing process improvements. (King, 1989, p. 1-11)

b. Horizontal Teams, Information System, and Audit tools

In cross-functional management horizontal teams consisting of customers, suppliers, and people from within the organization, come together to manage critical processes and systems. The information system and audit tools make it possible to convey the right information, such as that obtained thru the use of QA/QFD, to all the right people and to audit the progress of process improvement. (King, 1989, p. 1-11)

B. MENTAL MODELS REGARDING MANAGEMENT CONTROL

1. Mental Models regarding Planning and Problem Solving

a. The Planning System is Customer Driven

An organization must know what customers will want 5 to 10 years from now and exactly what it must do to far exceed all expectations. The fact that the customer driven master plan is the hub of all other management control activities, illustrates this mental model.

b. Team effort is more productive than individual effort. All problems and challenges are met by a team of the most appropriate people, regardless of their levels or job within the organization

An example of this is that employees will join with work groups and are capable of generating 100-200 suggestions per year (2-4 per week), of which most may implemented. The GOAL/QPC model uses teams as the main method for achieving daily control, Hoshin planning, and cross-functional management.

c. Although strategies are set by the President/CEO, everyone's input is valued

The Hoshin planning section incorporates this mental model. The president sets two or three of the most important goals for the year. Every manager knows these strategies and personally determines two or three of the most important tasks to help achieve them. Each manager has measurable milestones for their activities which he or she personally documents and audits monthly, and sends them up

through the organization to enable diagnosis for continuing improvement.

d. You can't control what you don't measure

As the model illustrates, the GOAL/QPC MCS makes use of statistical methods and other tools such as audits and planning tools.

e. Quality must be managed daily

In the Goal/QPC model quality and reliability are managed and measured daily. Daily control or management is a system which enables everyone to know what they have to do a daily basis to make the organization run smoothly. It is also what everyone has to measure and control to make sure this happens. (Moran, 1991, p. 4)

2. Mental Models regarding People

a. Employees know and will do their job

Employees know what they must do to make the organization run smoothly. The actions of employees that have been empowered need not be documented, audited, and updated daily. The GOAL/QPC model assumes that empowered employees are capable and in fact do manage their daily routine. Additionally, they are capability of adapting to changing situations as required.

b. Employees are capable of analyzing problems

Each employee, given simple tools to understand variability and data, is capable of analyzing problems and managing by facts. The Hoshin planning section of

GOAL/QPC's model provides employees with tools for understanding analyzing problems and thereby managing by facts.

c. Employees know the most important variables to control

Every employee in the organization knows the most important variables to control in order to meet or exceed the needs of the customer and to improve the process continuously. Additionally, they are capable of documenting and updating these standards. Hence, GOAL/QPC leaves daily control to the creators.

d. Employees know how to improve their jobs

Employees not only understand how to do their job; they also know how to significantly improve their job on a regular basis. The GOAL/QPC model assumes that given the statistical tools and standardization will know how to use them for improving his or her job.

e. Employees know and regularly communicate with their suppliers

Employees know all the people who supply them with data or materials and they give these suppliers clear and concise advice on how to improve. This is an element of the cross-functional management section of the GOAL/QPC model.

f. Employees strive to continually improve the process or product

Hoshin planning emphasizes that employees and management monitor continuous improvement activities at each

level of the organization. Employees use this feedback for improving their skills and/or process.

3. **Mental Model regarding Information**

   a. ***All employees should have unimpeded access to information***

Empowered employees require unimpeded access to Information relevant to their process. Information must flow smoothly and concisely daily to the people who need it. The GOAL/QPC model provides employees with this information.

VII. COMMON ELEMENTS OF TOTAL QUALITY MANAGEMENT CONTROL SYSTEMS

The previous chapters examined the Canon and GOAL/QPC management control models in order to describe a typical specific TQMCS. These two examples merely illustrate what the authors found during their review of the literature:

> *There is no universal method for management control among total quality organizations. Each organization creates their own unique total quality management control system.*

However, there are common elements that can be found in all total quality management control systems. Each organization considering implementing a total quality management control system can use these elements as the foundation for building its own unique management control system. This chapter identifies the common elements shared by the Canon, GOAL/QPC, and other total quality management control systems. We begin with the underlying "mental models" of a total quality management control system.

A. MENTAL MODELS IN TOTAL QUALITY MANAGEMENT CONTROL SYSTEMS

Total quality management control systems examined possessed similar mental models regarding planning and problem solving, people, and information.

1. Mental Models regarding Planning and Problem Solving.

a. Each member of the organization controls their own process.

Control focuses on the process, not people. Total quality management control systems assume that each member in the organization does their best to pursue the organization's goals provided management does not rob them of their pride of workmanship. (Deming, pp. 77, 85)

A shared vision, mission, and values create great unity and a tremendous commitment throughout the organization. They create in peoples' hearts and minds a frame of reference, a set of criteria or guidelines, by which they will govern themselves and cooperate for the attainment of the organization's shared vision. (Covey, 1990, p. 143) In an organization that has a shared vision, values, and mission, creators will feel empowered and will do their best in controlling the process for which they are responsible. Therefore, managers and creators must control their own processes; the control authority is distributed throughout the organization (Figure 12). (Senge, 1990, p.

292) The Canon and GOAL/QPC models clearly illustrate this concept.

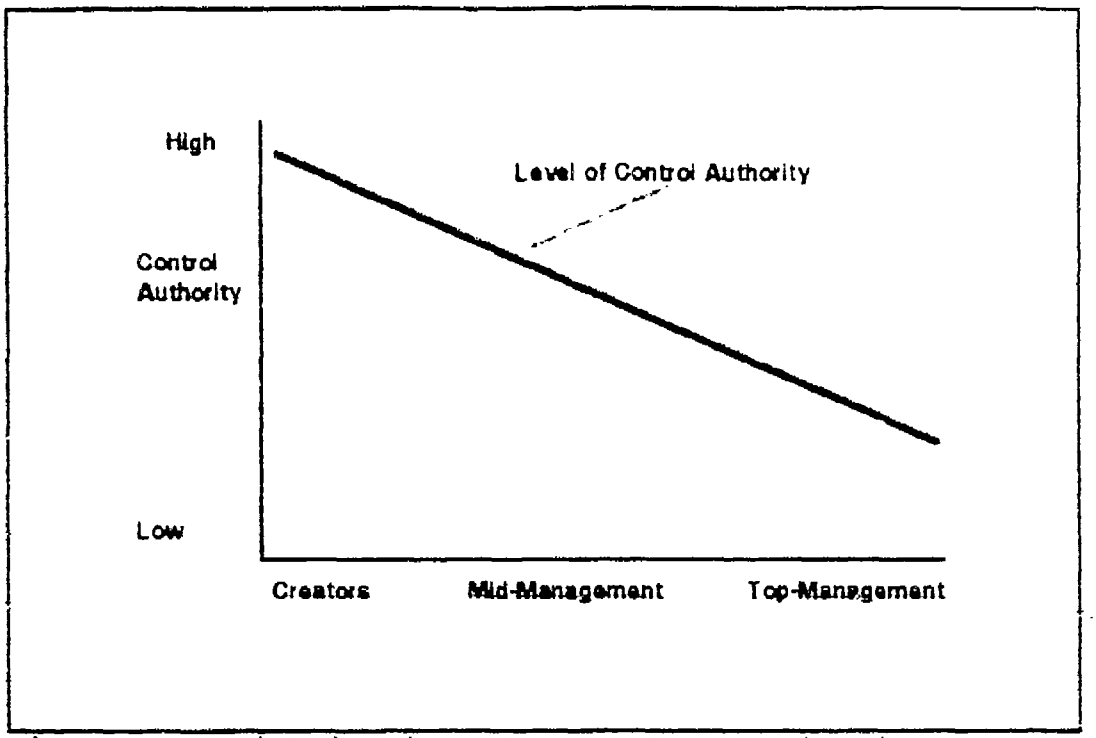

Figure 12. Distribution of Control Authority in a Total Quality Organization.

b. Each organizational level has some management authority, although, the higher the level the more management authority it has.

In a total quality organization, creators possess some degree of management authority. As mentioned in the previous mental model, creators have the control authority to control their processes. When process problems arise, the total quality organization delegates some management authority to the creators to deal with the problems. For example, if a production process where a filter is installed on an engine, goes out of statistical

control, it might be necessary to stop that line and change the procedure by which the filter is installed on the engine. The authority to stop the production line is managerial authority. Changing the procedures is also a managerial activity (as defined in Chapter I). In a total quality organization, the authority to take these actions is partially delegated to creators and lower levels of management (Imai, 1986. pp. 3,14).

Planning, in a total quality organization is another managerial activity in which creators participate. For example, both the Canon and GOAL/QPC models use the "catch ball" technique to facilitate participation of creators in planning.

In a total quality management control system all levels of the organization have a degree of managing authority since all levels of the organization take part in planning, problem solving, and process improvement (Figure 13).

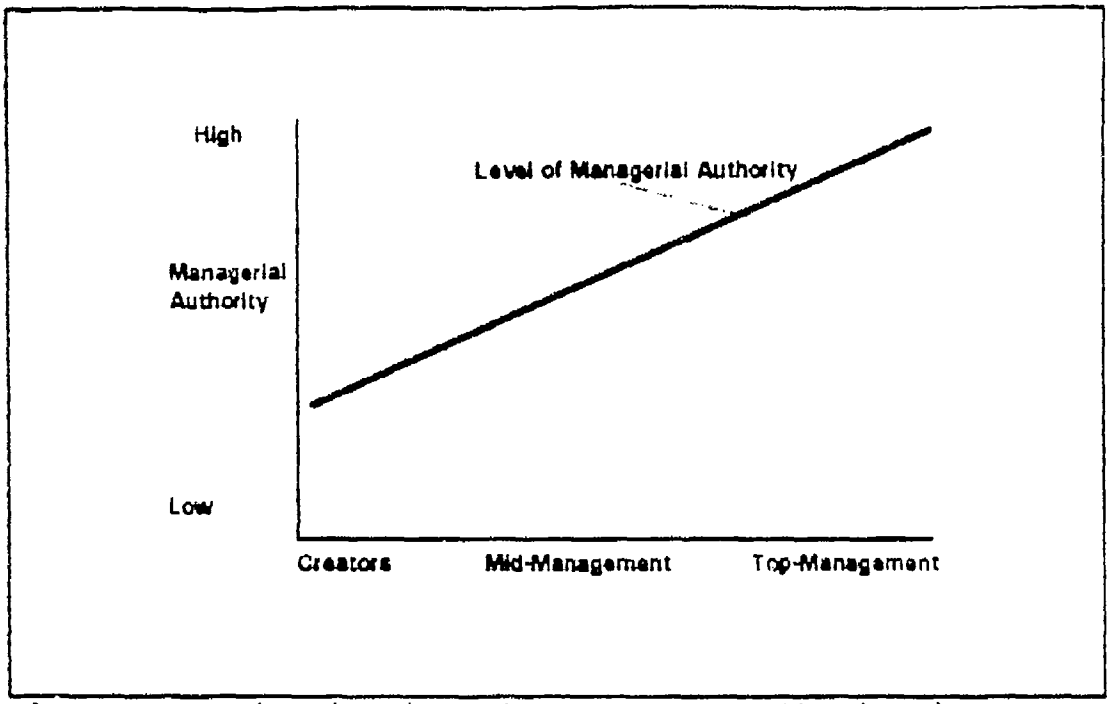

Figure 13. Distribution of Management Authority in a Total Quality Organization.

c. *An organization can achieve more than the sum of its sub-units achievements.*

There is a system of interdependence between and within all subdivisions of an organization. Subdivisions within a total quality organization are well coordinated and support each other in pursuit of a common mission. Therefore, as a cohesive group, sub-divisions can achieve far more than the sum of their individual achievements. As an example of a system that is interdependent or well-optimized, Dr. Deming uses the example of an orchestra. The players are not there to play solos, each player tries to support the others. Individually, they may be the best players in the

country, but together they are great. Likewise, the individual divisions of an organization are not solo acts, but rather, they are interdependent. (Deming, 1992, p. 65) For instance, a major element of the GOAL/QPC model is the emphasis on cross-functional management.

d. ***Even if we know what the symptoms are, it is still a complicated task to define the root causes of organizational problems.***

The cause of a problem might be far removed from the symptom which indicates the problem; moreover, one action might have dramatically different effects in the short run and the long run. (Senge, 1990, p. 71) Common and special causes must be identified and isolated otherwise there will be confusion and frustration throughout the organization because the wrong problems will be taken care of. This confusion and frustration will lead to greater variability in the end product and higher cost, exactly contrary to the desired organizational objectives (Deming, 1986, pp. 314-315).

Total quality management control systems use the Deming cycle to map out every conceivable event or contingency that can occur (King, 1989, pp. 4-28). They establish sophisticated methods to analyze problems and identify the root causes for these problems. (Cohen, 1993, pp. 76, 116) Although not explicitly mentioned, the fact that TQMCS expend scarce resources towards identifying root causes illustrates the importance they place on this effort.

2. **Mental Models regarding People**

a. ***Managers will exercise self-direction and self-actualization toward achieving objectives to which they are committed; this cannot be measured by a short-term quantitative standard.***

As previously mentioned in Chapter IV, an organizational vision -- one that reflects the deep shared vision of a manager or creator -- will bring out extraordinary commitment from that manager or creator. A manager or creator who feels ownership of an organization's vision, values, and strategy will be motivated to fully support that vision, values, and strategy. In total quality management control systems managers (and creators) are part of the process for developing the vision, mission strategy and values. As a result, they are deeply committed to accomplishing the organization's mission. Therefore, as committed managers they will exercise self-direction and actualization (Covey, 1990, p. 143). Both the Canon model (Chapter V) and GOAL/QPC model (Chapter VI) used training and empowerment to foster self-direction and actualization.

b. ***All of an organization's members should participate in the planning and continuous improvement processes.***

The total quality management control system empowers creators and managers by encouraging them to participate in the process of continuing improvement (Imai, 1986, pp. 3,14). As an example; the management control systems of Japanese corporations measure the number of suggestions given by line workers (Imai, 1986. pp. 111,

124). In Chapter V, we saw that the Canon model had developed a subtle mechanism for planning that involved all levels of the organization. The same is true although in a slightly lesser degree in the GOAL/QPC model. Since everyone in the organization participates in the decision making process, better ideas are generated and people are more highly committed.

3. **Mental Model regarding Information**

   a. ***Most of the information essential to managing and controlling an organization can be gathered in the form of processes' performance.***

The total quality management control systems assume that people will do their best for the company, hence, there is no need to measure individual performance. Furthermore, performance measurements tend to encourage managers and creators to "play by the numbers" which results in inefficiencies. Total quality management control systems do not use performance measurements, instead, they measure processes and quality. For example; a creator is not measured against a quota, but rather, the creator measures the quality (as defined by his internal or external customer) of his or her process while the creator's manager may measure the quality and arrival schedule of raw materials needed for that process (Masaaki, 1986, p. 46).

B. VISION

Total quality management control systems emphasize shared vision as an important element of their control system (Senge, 1990, pp. 205, 232). Once a vision is shared (not imposed but inspired by management), people in the organization feel ownership for it. Since people own the vision, they direct themselves toward the vision, they do not need a manager to control them. Canon's vision is described in Chapter V. In the GOAL/QPC model the Customer-Driven Master Plan provides the vision.

C. VALUES

Values are a set of criteria by which people in the organization can judge and decide what can and can't be done on the way to obtaining the vision. For example, a company that adopts a value of a clean environment would not pollute a river flowing nearby. This company will not pollute, even if polluting did not violate the law and would save the company a lot of money. Values limit the space through which a company moves towards its vision.

A total quality corporation has a shared set of values. As an example of values, an organization may value its employees to the point of providing lifetime employment. If values are shared by the entire organization, fewer management controls are needed. In the Canon and GOAL/QPC models, creators are valued for their knowledge and have

input into the organizations vision, goals, and strategies. An organization's values create a path for the organization to follow while pursuing its vision. This path is further defined by strategy and goals.

D. STRATEGY

Strategy is congruent with vision and is positioned within the shared values of the organization. A total quality organization has a shared long-term plan (a strategy) directed at enhancing its competitiveness. For example, one part of a strategy might be to concentrate on one line of products and differentiate from other manufacturers by superior quality and service. The process of creating a long-term plan and strategy is a top-down and bottom-up process. The process is *led and inspired* by management but inputs from all the organization's members are incorporated in the plan. As a result, people understand the strategy and are committed to accomplishing it. Therefore, managers at all levels are likely to make the right decisions in pursuing the strategy.

Both the Canon and GOAL/QPC models require management to use "catch ball" when developing strategic plans. The process of setting strategies in Canon is initiated and led by top management but everyone's input is ultimately incorporated in the strategies.

Total quality management control systems also establish goals and objectives which are a compass or a road map for accomplishing the strategy.

E. GOALS AND OBJECTIVES

Specific goals and objectives are determined and measured by both functional and interdisciplinary teams. Team members, those tasked with accomplishment, set goals that ensure the organization is following its strategy toward the vision and within the values, and determine process measurements necessary to ensure that goals are met. Some examples of possible specific goals and objectives are:

- To deliver every order within a month from the day ordered by the customer. This goal would be determined by a team whose members were from; sales, production, materials, shipment and suppliers
- To reduce last year's product failure rate. Representatives from R&D, engineering, production, materials and suppliers might set this goal
- To shorten the service reaction time of last year. This goal would be discussed and set by the service departments; service engineers, service dispatchers and operators
- To reduce factory air pollution by 80%. People from manufacturing, R&D, and government environment agency set this goal

Canon's self-management activities and small groups participate in managing the day to day routines of the organization such as setting short term-goals and measurement of processes. Canon's detailed planning procedures also incorporate input from creators as well as from managers. The GOAL/QPC model, like Canon's, uses both

functional and interdisciplinary teams to set goals and plans.

F. CENTRALITY OF THE CUSTOMER

Total quality management control systems place the customer in the focal point of attention. A "customer" is not only the ultimate customer who purchases the product, but is every person, team, or unit that receives a product or a service in the process of converting inputs to outputs. A customer inside the organization is an "internal customer" and a customer outside the organization is an "external customer." Quality is defined as customer satisfaction, and the goal of everyone in a total quality organization is to strive towards increasing external and internal customers' satisfaction. "Quality should be aimed at the needs of the consumer (customer), present and future." (Deming, 1986, p. 5) Every unit, team and individual has to measure their customers' satisfaction.

As was shown in Chapter VI, customers are central to the GOAL/QPC model. Canon's vision in Chapter V is to be a world-class or premier corporation. Its company wide goals of striving for the best quality, the lowest cost, and fastest delivery anywhere are all central to customers' needs.

G. LONG TERM SUPPLIER RELATIONSHIPS

Suppliers, like customers, might be external or internal. Total quality management control systems build long-term relationships with suppliers based on mutual trust, not on the lowest bid. A supplier is measured first on the quality of his materials, with special attention to variation, schedule, and quantity. Cost is the secondary consideration. The supplier is responsible for measuring all the factors mentioned above on his or her own. The organization is expected to share information regarding current and future products. When suppliers and customers form partnerships it becomes a win win situation for both. (Deming, 1986, pp. 31,32)

At Canon, outside suppliers furnish seventy to eighty percent of all parts used. For this reason it is very important that Canon select suppliers who will cooperate with Canon's quality effort. Canon's quality assurance personnel work closely with suppliers to make the improvement methods and quality management techniques developed by Canon available to them. This close working relationship can only be accomplished by establishing a climate of mutual trust and long-term support.

The cross-functional system of the Goal/QPC model also requires a long term commitment from the supplier and organization.

H. MEASUREMENTS

Measurements are the means by which an organization develops a shared perception of reality. Senge describes the perception of reality as a "commitment to the truth." He says that a commitment to the truth "means continually broadening our awareness, just as the great athlete with extraordinary peripheral vision keeps trying to see more of the playing field." (Senge, 1990, p. 159)

A total quality management control system continuously strives to improve the accuracy of its perception of reality through the extensive use of measurements. Measurements are mostly accomplished by the people who work in the process being measured. Each organizational level, creators and managers, decide what and how to measure the processes they are responsible for. Creators, as well as managers, are empowered to act on the information provided by their measurements. If a process goes out of control they investigate the root causes and determine how to remedy the situation. Since measurement is used as a tool for continuous improvement vice evaluation, the probability of manipulation of data to provide the best possible picture is reduced.

For example, a team that serves food in a fast-food restaurant might decide to measure how long the que is in the restaurant. Once the que length is longer than the upper limit they will act to correct that problem. If the

que is shorter than the lower limit they will investigate the causes. If applicable, they will change procedures and policy to keep the que short.

The Daily Control portion of the GOAL/QPC management control system illustrates this focus on measurement through the use of standardization and statistical methods. Canon's Quality Control is interested in the quality of the process and only examines whether a process is well documented and measured. Actual measurement is done by the process owner; the team or the person to which the process is assigned.

A detailed discussion of measurement as it relates to a TQMCS is provided as Appendix C.

I. FIRST-HAND DATA COLLECTION

Deming says that a company should not run on visible figures alone. (Deming, 1986. p. 121) First-hand data collection is a means by which management collects non-numerical data.

Total quality management control systems form means by which top management collects first-hand information. Top management must balance the information they collect between formal reports, meetings with external customers, meetings inside the organization, tours of the different subunits and informal discussions with people all over the organization. As described in Chapter V, Canon uses the "Doctor Round" as

a means by which top management can get first-hand impressions.

J. FREE FLOW OF INFORMATION

Deming's ninth point is "break down barriers between staff areas." (Deming, 1986. p. 62) As mentioned above, the most important measurement at all levels of a total quality management control system is customer satisfaction. To measure internal customer satisfaction a free flow of information inside the organization is necessary because teams must measure the next team's satisfaction.

The free flow of information is also important to other aspects of the TQMCS. Creating shared strategies and setting shared goals and objectives requires free flow of information; otherwise it is impossible to coordinate many inputs into a sound cohesive plan.

The Canon model in Chapter V assumes that continual improvement translates to change and growth. For an organization to have both growth and change, it must also have thorough and continuous sharing of information. In the Canon model, shared information must be concrete, objective, and sufficiently detailed to promote growth.

The GOAL/QPC model in Chapter VI assumes that information allows creators and managers to operate and make fact based decisions.

K. AN ILLUSTRATION OF THE COMMON ELEMENTS OF TOTAL QUALITY MANAGEMENT CONTROL SYSTEMS

Figure 14 illustrates how an organization pursues its vision within the constraints of its strategies and values. Shared vision, serves as a common destination. Top management *inspires* the vision-setting; they do not impose the vision on the organization. Therefore, people throughout the organization feel ownership of the vision and they direct their activities toward attaining it. Values, as seen in Figure 14, are used as boundaries within which an organization moves toward its vision (There are conceivably other means that could serve the purpose of moving toward the vision, but, they will not be used if outside the boundaries of the shared values). Values, like vision, are inspired, not imposed.

Strategy, is a set of long-term plans that can be presented by a network of roads that lead to the vision. All of the roads must be within the values' boundaries. The process of setting a strategy is top-down and bottom-up. Inputs from all organization members are incorporated.

Goals and objectives are the exact paths that an organization follows in pursuit of its strategy and vision. Setting goals and objectives require enormous amounts of information from inside and outside the organization. The process of setting Goals and objectives is illustrated in Figure 15. Since vision, values and strategy are shared, lower levels of managers and creators can determine goals

and objectives congruent with the organizations' strategy. Setting goals and objectives in a Total quality management control system is a bottom-up and top-down process.

Once the desired path is determined, it is necessary to evaluate where the organization is in relation to its goals and objectives; to evaluate its current situation. A Total quality management control system develops a method by which an organization creates a shared perception of reality. Every person (or a team) measures the process which he owns. The process is measured, not the person, and everyone measures his process, not the process owned by his subordinate. All the information collected in all levels of the organization is the "shared perception of reality." Since everyone measures his process, there is no incentive to manipulate the numbers. Therefore, in a Total quality management control system, the shared perception of reality tends to be accurate and objective. The importance of an accurate perception of reality cannot be over emphasized.

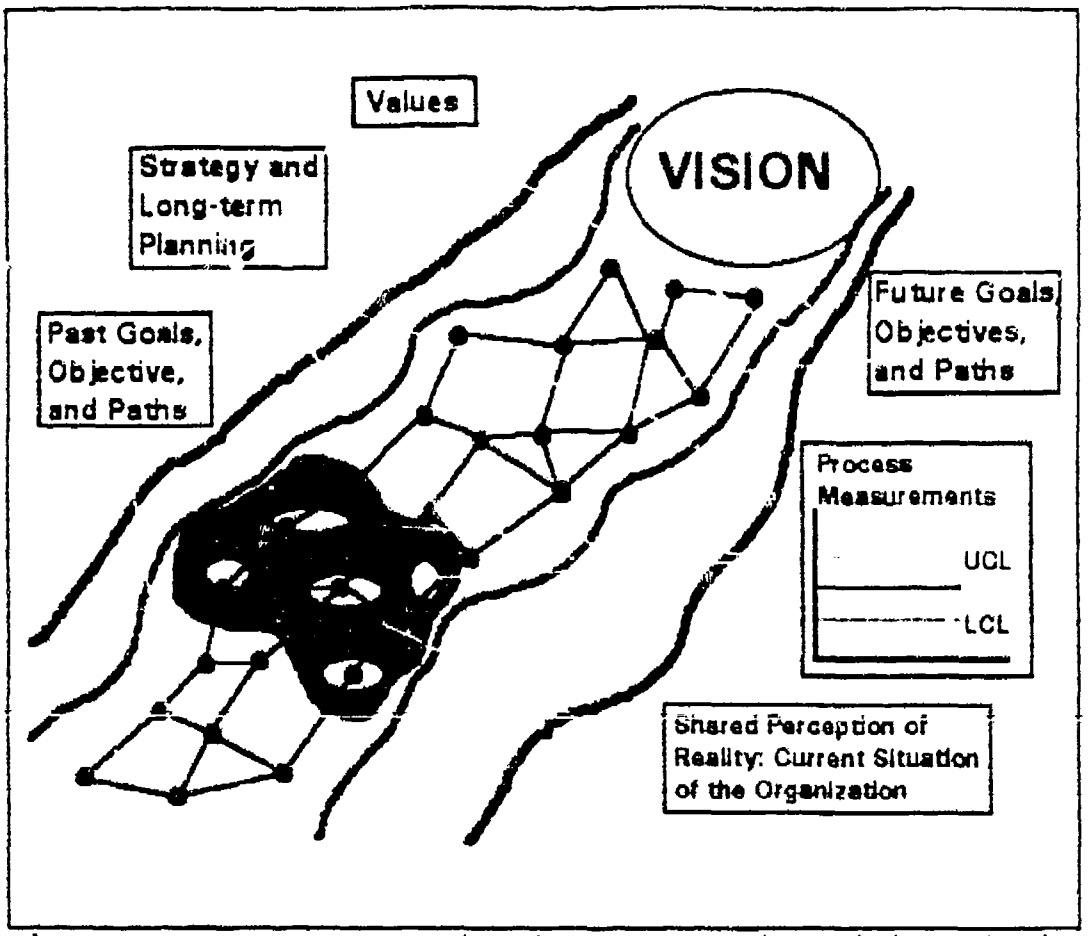

Figure 14. How an Organization pursues its Vision within the Constrains of its Strategy and Values.

Figure 15 explains the goals, objectives, and paths illustrated in Figure 14. Figure 15 demonstrates the complexity of setting goals and objectives due to the need for enormous amount of relevant information. In order to use all the relevant information effectively, the process of setting goals and objectives must be decentralized and delegated to lower levels of the organization. The vehicle for this demonstration is a simplified process of developing and producing a new product. Under the horizontal axis

several departments are listed, as well as, customers and suppliers of the organization. Stages of development are listed along the vertical axis, starting from pure research and ending in production. Each goal is represented in Figure 15 as a numbered dot. Goals, numbered 1, 2, 6, and 13, are under the responsibility of the research and development (R&D) department, goals number 5 and 11 are under production's responsibility, etc.

Before one accomplishes a goal, they must receive some inputs that will allow them to complete the tasks required to accomplish that goal. For example, for R&D to conduct research and development, the Treasurer must first provide funds. As another example, before production starts, R&D has already delivered detailed information about the product and related systems to Production. Also, Marketing must create demand for the new product before the product reaches the market (Marketing "delivers" the customers for the new product).

Information is only one of many types of input. In Figure 15, two kinds of information are illustrated: product information (pi), which is information that describes the product; and, general information (i), which is information necessary for the process of developing and manufacturing a new product.

The grey lines shown in Figure 15 represent the paths through which information flow through the customer-supplier

chain. These paths are labeled as to the type of information (pi or i) supplied to a particular customer.

- Goal number 1 specifies a research target. This stage is done by R&D. Though, funds come from the controller (or treasurer)
- Goal number 2 specifies an early stage of a development target. Information from all other departments and suppliers and potential customers is needed to accomplish this target (i=general information)
- Goals number 3 through 8 are mid-development targets. All participants need information about the planned product (pi=product information), so that they can gear themselves up for production

(Goals number 9 through 15 represent the end of development and beginning of production.)

- Goal number 13, R&D must deliver all product related information to production department
- Goal number 9, Suppliers must be ready to supply materials for production
- Goal number 10, The service department must be ready to deliver service to customers
- Goal number 11, The production department must produce the products
- Goal number 14, The controller must fund activities related to the introduction of the new product
- Goal number 15, Marketing department makes sure that customers are ready to purchase the product

As mentioned above, this example is simplified. A "real" process of development and production is much more complex. It requires an interdisciplinary team which constantly interacts during the process of development. An enormous amount of information is transferred inside and outside of the company. Many formal and informal goals and objectives must be met. No one controls *the entire process*. A total quality management control system allows people who do the work to set goals and to coordinate activities.

Management and the development team decide when the new product must be ready for shipment. Then, the team takes control of development and occasionally informs management.

Since the process is controlled by those who actually do the work, they have all the necessary information to control and to accomplish their goals.

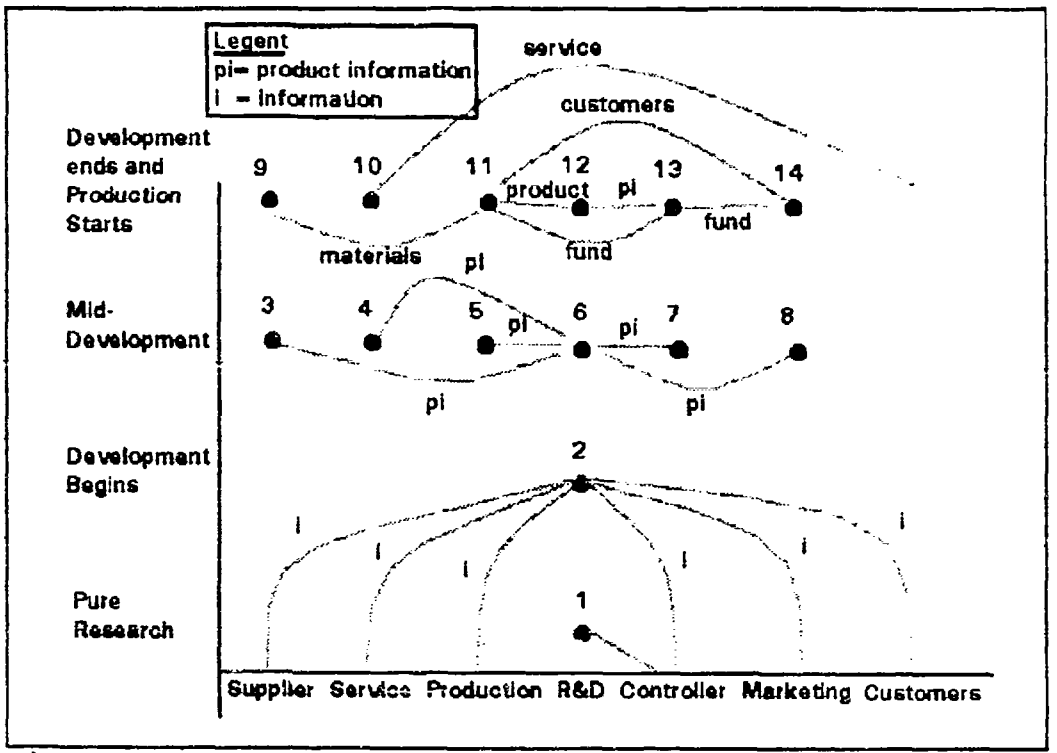

Figure 15. An explanation of the Goals and Objectives depicted in Figure 14.

L. CHAPTER SUMMARY

A total quality management control system is a product of mental models (see section A of this chapter). Its distinctive characteristics are:

- A shared vision, shared values, and shared strategy
- Goals and measurements are set and performed by those who actually do the work

Control, under this approach, is a function of and exercised by teams or individuals who actually accomplish the task. Management does not control the creators, but rather, management "leads people" and "manages the organization," as illustrated in Figure 16.

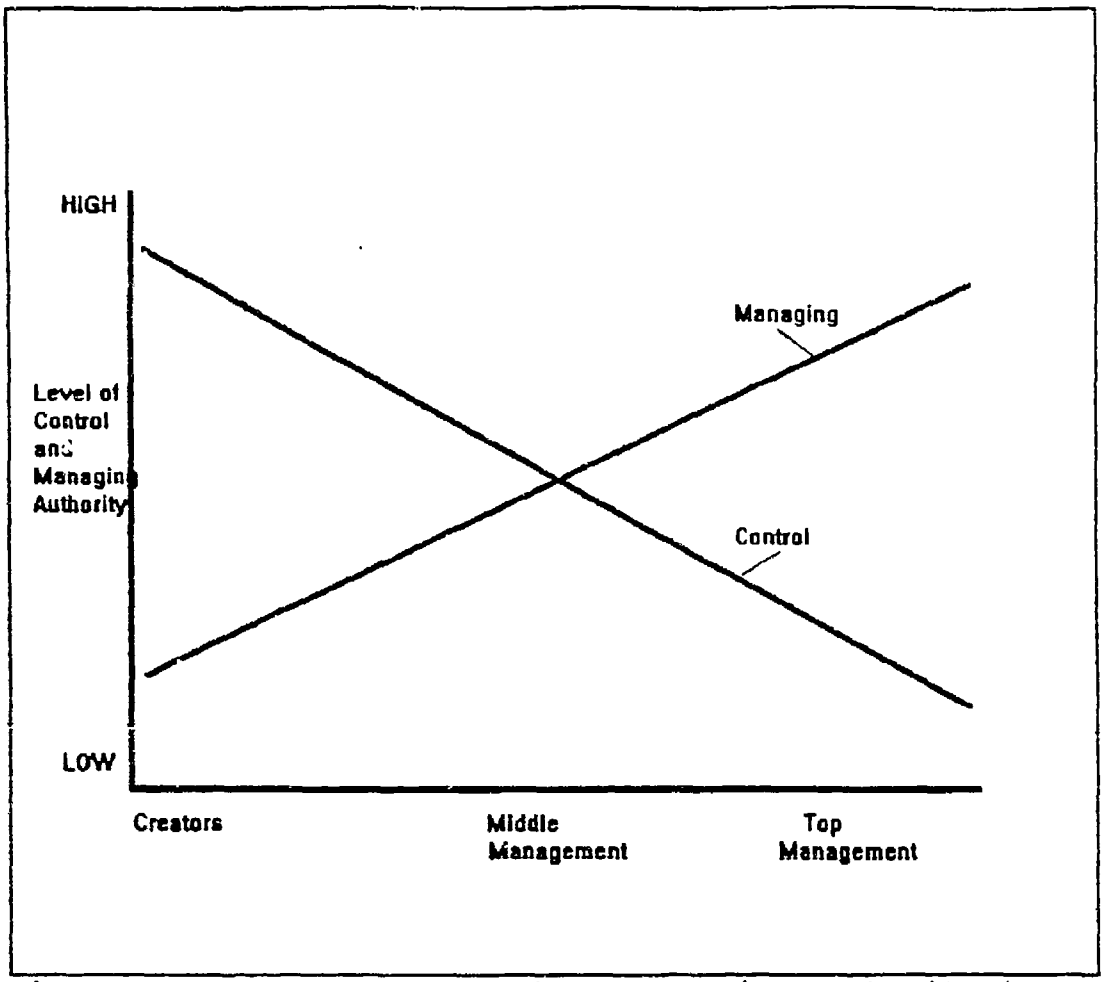

Figure 16. Levels of Control and Managing Authority in a Total Quality Organization.

VIII. A COMPARISON OF TRADITIONAL AND TOTAL QUALITY MANAGEMENT CONTROL SYSTEMS

Management control systems can be described as existing within a multidimensional space. Each dimension can be thought of as one attribute of a management control system. An attribute may be wholly, partially, or not possessed at all. For example, in the context of this thesis "strategy" is a dimension. We can measure a management control system against its posture towards strategy. Another dimension is "values." We can also measure a management control system against its posture towards values. Each mental model is also a dimension (control authority, management authority, goal congruence, problem solving, etc.). This Chapter compares traditional and total quality management control systems within these dimensions.

Dimensions important to either management control system were chosen for the analysis. These dimensions have been previously described in detail in Chapters III and VII, and will be synopsized in this Chapter. For ease of analysis and reader understanding, the dimensions have been organized into categories and groups. Groups contain one or more dimensions and categories contain one or more groups (Table 2). In the next section, the various categories of analysis

are listed along with their associated groups of dimension. See Table 2.

TABLE 2. ORGANIZATION OF CATEGORIES, GROUPS, AND DIMENSIONS

Categories	Group	Dimension
		Dimension
	Group	Dimension
		Dimension

A. CATEGORIES OF DIMENSIONS

1. Mental Model Category

The mental models discussed in Chapters III (traditional management control systems) and VII (common elements of total quality management control systems) are compared in this category.

a. The Group of Dimensions that deals with Mental Models regarding Planning and Problem Solving.

- The Control authority dimension
- The Management authority dimension
- The Goal congruence dimension
- The Problem solving dimension

b. The Group of Dimensions that deals with Mental Models regarding People.

- The Managers' motivation dimension
- The Line workers' role in the organization dimension

c. The Dimension that deals with the Mental Model regarding Information.

- The Information dimension

2. **Planning Category**

Under the planning category we list all dimensions that relate to future activities of the organization. How the organization will perceive of itself in the future, its future plans and activities, and any limitations on those activities are all examples of dimensions within the planning category.

- The dimension of Vision
- The dimension of Values
- The dimension of Strategy
- The dimension of Goals and Objectives

3. **The Relationship of Customers and Suppliers Category**

This category deals with the dimensions that describe relationships between the organization and its customers and suppliers. Customers and suppliers might be external or internal to the organization, see Chapter VII.

- The dimension of Customers
- The dimension of Suppliers

4. **The Measurement Category (a one Dimension Category)**

The measurement category consists of only one dimension, the measurement dimension. The measurement dimension deals with several aspects of measurement which were discussed earlier in Chapters III, VII. The two management control approaches to measurement will be compared.

5. **The Control Practice Category (a one Dimension Category)**

This dimension was earlier defined under mental models. Here, however, the question of "who, in practice, really controls the process?" is examined.

6. **The Incentives Category (a one Dimension Category)**

The two management control systems (traditional and total quality) will be compared on their approach to incentives within the organization.

7. **Information Flow Category (a one Dimension Category)**

Information was previously addressed in mental models. But, under mental models the question was, "What information should management collect?" Here, the question of how that information flows within the organization is covered.

- The dimension of Freedom of Information Flow.
- The dimension of First-Hand Data Collection.

B. THE MENTAL MODELS CATEGORY

1. The Group of Dimensions concerned with Mental Models regarding Planning and Problem Solving

a. The Dimension of "Control Authority."

- The traditional model: *Only top management controls the organization*
- The total quality model: *Each member of the organization controls their own process*

Control as defined in Chapter I includes comparing an objective to a desired model. Though, traditional and

total quality management control systems both control the organization, they do so at opposite ends of a continuum as far as control authority is concerned. While an extreme traditionalist manager controls every action of his subordinates (Chapter III), an extreme total quality manager deals very little with control (Chapter VII). As Figure 17 illustrates, the TMCS and TQMCS are on extreme ends of a continuum regarding control and authority.

b. The Dimension of Management Authority.

- The traditional model: *Only management manages the organization*
- The total quality model: *Each level has some management authority although, the higher the level, the more management authority it will have*

A traditional manager does not delegate any management authority to the levels of line workers and first line supervisors. A total quality manager delegates management authority to lowest level of managers and creators on the factory floor. Traditional management activities such as control, process improvement, procedures update, and planning, are perform by creators as well as managers.

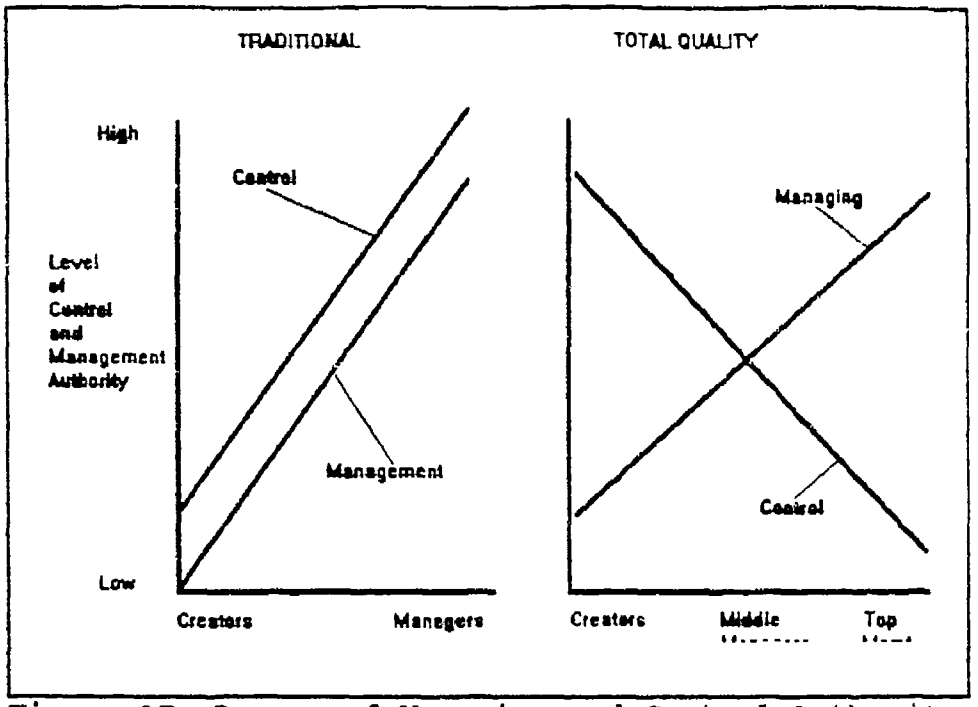

Figure 17. Degree of Managing and Control Authority in Traditional and Total Quality Organizations.

As Figure 17 shows, the total quality management control system delegates management authority to all levels of the organization, whereas, the traditional management control system reserves management authority for top management.

c. The Dimension of Goal Congruence.

- The traditional model: *An organization achieves its objectives if the sub-units achieve their assigned objectives*
- The total quality model: *An organization can achieve more than the sum of its sub-units*

A total quality management control system encourages cooperation between different segments in and out of the organization. The total quality culture commands a

close relationship between the organization, its customers, and suppliers. These relationships aid in breaking down any barriers that might exist within the organization. On the other hand, traditional management control systems create competition between different units. Each unit in a traditional organization tries to make its numbers look better than the other units and sometimes at the expense of the other units. For example managers might have confrontations over overhead allocation or transfer pricing. Each manager wants his colleagues to incur a larger part of the costs.

In an extreme total quality organization it might be hard to distinguish the organizational lines separating the different divisions. Managers and creators will cooperate by sharing resources and helping each other. Conversely, in an extreme traditionally managed organization the boundaries between divisions are clear and solid, resources are transferred from one division to another only after approval from a higher level of involvement, everyone tries to improve his or her results.

d. The Dimension of Problem Solving.

- The traditional model: *If we know what the symptom is, we can easily identify the source of the problem.*
- The total quality model: *Even if we know what the symptoms are, it is still a complicated task to define the root causes of the original problems*

Total quality management control systems expend considerable resources inquiring into processes in order to define the real problems and their root causes. In contrast, traditional management control systems deal most often strictly with symptoms. A traditionalist manager, like a total quality manager, understands that root causes of a problem must be corrected. But, they tend to identify root causes intuitively, usually without the aid of statistical tools. As stated in Chapter III, traditional management control system theory does not provide the tools required for a thorough analysis of root causes. Therefore, the traditional end of the problem solving continuum deals primarily with symptoms while the total quality end addresses root causes analysis and tries to detect problems before the symptoms appear.

2. The Group of Dimensions concerned with Mental Models regarding People

a. The Dimension of Manager's Motivation.

- The traditional model: *The best method to evaluate and motivate mangers is to measure their performance using quantitative standards.*
- The total quality model: *Managers will exercise self-direction and self-actualization toward achieving objectives to which they are committed; this cannot be measured by a short-term quantitative standard.*

While top management in traditional organizations motivates managers by using the "carrot and stick method," total quality management control systems motivate through shared vision, values, strategy, goals, and objectives. In

the total quality culture the belief is that once a manager participates in the process of decision making and his or her inputs are incorporated into the outcomes, he or she will be committed to pursuing the company's vision.

Hence, traditional management control systems can be recognized by a well developed set of performance measurements with each manager's compensation predicated on these measurements. Managers, knowing that they are measured and compensated by these criteria, are then motivated to do their best to improve their performance. In contrast, total quality management control systems can be recognized by a well developed set of process and quality measurements. The total quality organization that lies to the extreme end of the management and control continuum will not measure performance of individuals, Deming's third deadly disease (Deming, 1986, p. 98).

b. The Dimension of the Line Workers' Role in the Organization.

- The traditional model: *There is a clear division of roles in an organization: top management plans and controls, middle management controls and line workers do.*
- The total quality model: *All the organization members participate in planning and improving processes.*

The traditional management control system perceives workers as a necessary commodity for doing business. Since this commodity has a cost, management will try to cut those costs as much as possible. Furthermore,

since management purchases only the labor commodity, employees are not expected to participate in "thinking" activities. Employees under the traditional system are hired to work, not to think

The total quality management control system delegates a large degree of control and management authority to the creators (line workers) and middle management. These individuals have been empowered with this authority and control and are therefore expected to think. Because these individuals have authority and control, fewer layers of management are needed, people are highly committed, and better ideas are generated. Total quality management control systems tend to be much leaner in terms of personnel resources than traditional management control systems.

3. The Group of Dimensions concerned with the Mental Model regarding Information

- The traditional model: *Most of the information essential to managing and controlling an organization can be gathered in the form of sub-unit and individual performance.*
- The total quality model: *Most of the information essential to managing and controlling an organization can be gathered in the form of process performance.*

As discussed in Chapter III, traditional management control systems use sophisticated measurements to evaluate the performance of managers and subunits within the organization. This information is gathered in the form of subunit and individual performance and flows up to top

management. Numerical goals and objectives are communicated down from top management to the mid-managers and creators.

Information in the total quality management control systems is not used to measure individual or sub-unit performance. Traditional information concerning transfer prices, cost centers, profit centers, revenue centers, and investment centers is not developed or utilized. Total quality organizations cannot nor do they ignore information concerning financial performance. Primarily, financial performance measurements are for the use of top management and shareholders. Financial measurements in a total quality organization are used to measure the organization as a whole, not to measure sub-unit or individual performance. Non-financial information concerning processes performance is used by TQMCS. One example of this type of information might be measuring external or internal customer satisfaction.

On the traditional end of the information continuum, information is extracted to measure individual or sub-unit performance. On the total quality end of the information continuum, information is extracted for the purpose of measuring processes, quality, and performance of the organization as a whole.

C. A COMPARISON BY DIMENSION IN THE PLANNING CATEGORY

1. The Dimension of Vision

A traditional organization might have a vision statement even though the traditional management control theory does not deal with developing a shared vision. However, as previously discussed in Chapter VII, the total quality management control system emphasizes the importance of a shared vision in the organization.

2. The Dimension of Value

Every organization has values, either implicit or explicit. A street gang for example, will have values, they may not compare with those of an ordinary citizen but there will be values for that gang. For example, the gang may value mutual help or achieving a specific objective at any price. Organizations with total quality management control systems develop their own unique set of shared, explicit values. Some values (such as honesty within and without the company) will be common to most total quality organizations. Although the values may not be the same, the existence of an *explicit set of shared values* is common to all total quality organizations. An explicit set of values in a traditional organization, however, will most likely, be dictated by management.

If an organization has an explicit set of values *which are shared by most of the organization's members, that*

organization will lie toward the total quality end of the values continuum.

3. The Dimension of Strategy

At the total quality end of the continuum, each and every member of the organization contributes to the formation of the organization's strategy. Critical and strategic decisions are initiated and led by the higher levels of management, but input from all the organization's members are incorporated into those decisions and strategies. Goals and objectives in a total quality organization are usually set in a bottom-up process. However, under traditional management control, strategy is dictated to the organization by top management.

The content of the strategy will also be somewhat different at each end of the continuum. The total quality organization tends to incorporate the "process" part in its strategy in addition to focusing on end results such as profit or market share. For instance, a total quality organization will most likely incorporate in its strategy elements like improving its relationship with suppliers and customers, improving communication within the organization, or improving worker's skills in team work. The traditional organization will be mainly concerned with end results or the bottom line and have little focus on processes.

4. The Dimension of Goals and Objectives

A traditional organization involves middle and upper managers in the process of setting goals. A total quality organization will get all members of the organization involved in this process, because, the setting of goals is viewed as a bottom up process. Hence, on the traditional management control end of the continuum, goals will be set by top and middle management. At the total quality management control end goals are set by teams of employees and middle management.

D. A COMPARISON BY DIMENSION IN THE CUSTOMER AND SUPPLIER RELATIONSHIP CATEGORY

1. The Dimension of Customers

Both management control systems attribute great importance to customer satisfaction and both systems encourage managers to measure it. Total quality management control systems, however, expand the term "customer" to everyone who receives anything in the process of creating the product or service. Therefore, the total quality approach *measure internal and external customer satisfaction*. Traditional management control systems, if they measure customer satisfaction at all, will normally measure external customers.

2. The Dimension of Suppliers

Both traditional and total quality management control systems measure criterion standards for materials received from suppliers. The traditionalist will emphasizes cost and quantity and quality within a set of specifications while total quality systems emphasize quality, minimum variation, and timeliness as the most important criterion standards.

Total quality organizations work with suppliers to ensure these criterion standards are met. Furthermore, a total quality organization will create a partnership with its suppliers. Information will be freely exchanged and inspection of incoming materials will be the responsibility of the supplier.

E. A COMPARISON BY DIMENSION IN THE MEASUREMENT CATEGORY

Table 3 summarizes the approach to measurements by both types of management control systems.

TABLE 3. A COMPARISON BY DIMENSION IN THE MEASUREMENTS CATEGORY

	TRADITIONAL	TOTAL QUALITY
NATURE of CRITERIA	Financial	Process Performance
MEASURED BY	Accountants	Creators and Managers
MEASUREMENTS USED BY	Management	Creators and Managers

As one can readily see, and, as is extensively documented in Chapter VII, total quality management control systems do in fact measure the "bottom-line." However, the primary focus of their efforts is on measuring the performance of the process, which is not necessarily financial in nature. In contrast, the traditional management control system mainly measures financial performance. The two systems also differ in who measures: staff accountants verses people who own the processes; and who uses the measurements: management verses people who own the processes and are empowered to make changes to them.

F. A COMPARISON BY DIMENSION IN THE CONTROL PRACTICE CATEGORY

Both management control systems control the organization in such a way as to ensure the organization remains on the right track. However, in a traditional system, each level of management measures the performance of its subordinates; control is achieved through an elaborate network of reports flowing up from the bottom up, (see Chapter III). Conversely, in a total quality environment, each individual or team measures and controls itself or themselves, (Chapter VII).

Another significant difference between the two systems is the delegation of authority: a traditional organization limits its members authority as a tool for control (Chapter III), while total quality organizations delegate as much

authority as possible to the people that actually do the work, (Chapter IV, V, and VII). For example, in the traditional organization a department manager must approve changes in procedure (a tool for maintaining control over his department), while in total quality organizations, line supervisors can approve these changes within certain guidelines.

These differences have a profound effect on the organization. Management, in total quality organizations, spends much less time on "control," relative to that of a traditional organization. In the total quality organization people feel more empowered since no one is constantly looking over their shoulder to ensure they are doing their job. A total quality organization, as a whole, will expend fewer scarce resources on producing and disseminating reports. See Table 4.

TABLE 4. CONTROL DIFFERENCE IN TRADITIONAL AND TOTAL QUALITY MANAGEMENT CONTROL SYSTEMS.

	Traditional	Total Quality
Who Controls	Next higher level controls lower levels	Individuals control themselves
Limited Authority: Level of Authority for Decision Making	As high in the organization as possible	As close as possible to the process
What is Controlled	Individuals and Sub-units	Processes
Effect on the Organization:	• Management spends much time controlling • Generation of a sophis-ticated network of reports • People are tightly controlled	• Less management time required for control • Minimum number of reports are generated in the organization • People feel empowered

G. A COMPARISON BY DIMENSION IN THE BENEFITS CATEGORY

All managers want their subordinates to have an incentive to pursue the company's goals and strategy, Table 5 describes benefits or incentives as used in traditional

and total quality management control systems. The traditional management control system deals explicitly with incentives. Traditional managers attempt to create a system of incentives which are congruent with the company's goals and strategies. The incentives are in the form of rewards, or penalties in the case of disincentives. As an example, a manager's incentive might be: if he can cut costs by ten percent he will get a five hundred dollar bonus. But if he doesn't cut costs then he loses his bonus and possible promotional opportunities. These rewards and penalties will ultimately direct organization members along the organization's chosen path (Chapter III). Incentives are usually offered only to managers and workers who performed exceptionally well and are usually given on an individual basis.

Total quality managers motivate members within the organization through empowerment. Benefits are usually given to teams and are given as a recognition for an unusual effort or for new skills acquired. Table 5 illustrates the differences between the two methods in the benefit dimension.

TABLE 5. BENEFITS IN TRADITIONAL AND TOTAL QUALITY MANAGEMENT CONTROL SYSTEMS.

	Total Quality	Traditional
Benefits given to:	Teams	Individuals
Benefits given as:	A reward related to *past* activities	An incentive related to *future* activities
Benefits given because:	Put forth an enormous *effort*	Exceptionally good *results*

H. THE INFORMATION FLOW CATEGORY

1. The Dimension of Freedom of Information Flow

Free flow of information is an important element of a total quality management control system.

Control, as executed in the total quality management control system, is not dictated from above. It is, in essence, self-control. A crucial element of this "control" is internal customer satisfaction. The only source for information regarding internal customer satisfaction is the internal customer. Therefore, it is very important that information flow laterally (not just vertically) within the organization, from customer to supplier and back again.

Traditional management control systems are indifferent to lateral free flow of information.

2. First-Hand Data Collection

Managers in both systems intuitively balance their sources of information. H. Warpp says that a successful manager "keeps open many pipelines of information" (Mintzberg, 1992, pp. 32,33). However, total quality management control systems tend to put more emphasis on first hand data collection as a systematic method (i.e. Cannon's doctor rounds, Chapter IV).

I. CHAPTER SUMMARY

This chapter compared traditional and total quality management control systems. The two systems were compared against a set of dimensions on a scale of 1 to 9. Table 6 summarizes the dimensions and briefly defines the extreme total quality and traditional ends of the continuum. As one can see, the two systems are dramatically different within these dimensions. Mostly, the differences are a result of the difference in the mental models underlying each system.

TABLE 6. SUMMARY OF DIMENSIONS AND DEFINITIONS OF CONTINUUM

DIMENSION	TRADITIONAL	123	456	789	TOTAL QUALITY
1. CONTROL AUTHORITY	Top-management Controls				Self-control
2. MANAGEMENT AUTHORITY	Primarily management manages				Management authority delegated
3. GOAL CONGRUENCE	Organization equals sum of sub-units				Organization greater than sum of sub-units
4. PROBLEM SOLVING	Emphasizes symptoms				Emphasizes root causes
5. MANAGERS MOTIVATION	Enhanced by measurements				Managers are motivated
6. WORKERS' ROLE	Management thinks, workers do				Workers think and work
7. RELEVANT INFORMATION	Individual's performance				Processes' performance
8. VISION	May have a vision				Shared vision
9. VALUES	Dictated values				Shared values
10. STRATEGY	Top down strategy				Top down and bottom up
11. GOALS and OBJECTIVES	A top down process				A bottom up process
12. CUSTOMER	Ultimate customer				Internal and ultimate
13. SUPPLIERS	Cost, quantity and schedule				Partnership
14. MEASUREMENTS	Financial criteria				Non-financial criteria
15. CONTROL PRACTICE	Individuals controlled by manager				Individuals control self
16. BENEFITS (given for)	Individuals end results				Team's effort
17. INFORMATION FREE-FLOW	Vertical flow of information				Horizontal and vertical flow
18. FIRST-HAND DATA COLLECTION	Done intuitively				Done systematically

IX. A CASE STUDY: ACUSON CORPORATION'S SYSTEMS MANUFACTURING

A. METHODOLOGY

1. Organization Entry Approach

After deciding upon the thesis topic, it was then necessary to find a company that fit the essential requirement of the case study (a company that had adopted and used the TQ philosophy for at least 2 to 3 years) and would allow outsiders into their organization to conduct a resource consuming case study. At the suggestion of Linda Wargo, contact was made with Mr. Dan Robertson, an active participant in the San Francisco Bay Area Deming Users Group. Mr. Robertson suggested a number of companies he thought would fit the requirements for this case study. Initial contact was made over the telephone and followed up with a letter (see Appendix B) to those companies that expressed an interest in the thesis and appeared qualified for the case study. A semi-final list consisted of only two companies, KOMAG Inc of San Jose, CA., and ACUSON Corporation of Mountain View, CA.

Appointments were scheduled with top management in both companies for November 19, 1993. During these meetings the thesis topic and general outline for the case study was discussed and tours of the manufacturing facilities were conducted. After this initial meeting, KOMAG declined

further participation. A second meeting was scheduled with ACUSON'S Systems Manufacturing (ASM) staff. During this meeting the thesis topic, case study, and resource requirements were again discussed and concerns of individual staff members were addressed. The authors estimated that 15 to 30 interviewees would be required for one hour each or a total of 15 to 30 corporate manhours. Furthermore, the authors suggested that each manager decide who and how many subordinates would be allowed to participate in the case study. It was agreed upon that the authors would sign a form pledging to protect ACUSON'S proprietary information and that ASM would have final approval on the case study before it is published. ACUSON receivables would be the thesis (which includes the case study) and feedback from the authors on ASM in general. It is important to note that Mr. Brad Anker, Vice President of Manufacturing, would not make a final decision by himself, rather it was made through a team process, hence, the requirement for the second meeting.

ACUSON'S Systems Manufacturing decided to allow the researchers to conduct the case study of their organization. Mr. Pat McMahon, the Continuous Process Improvement Manager, was assigned as ACUSON'S Systems Manufacturing point of contact. Mr. McMahon and his staff scheduled the conference rooms, personnel interviews, and facility tours.

2. Data Gathering

Methods used for gathering relevant data were:

- Personnel interviews
- Observations during walk-arounds and attentiveness to conversations in the cafeteria and other common areas
- ACUSON'S annual reports to shareholders
- A previous Continuous Improvement Survey commissioned by ACUSON

a. Personnel Interviews.

Personnel interviews were conducted with thirty-five individuals in ACUSON'S Systems Manufacturing, ten percent of the population, ranging from the Vice President of Manufacturing to creators on the assembly line. The interviews were conducted using the interview form in Appendix C. Approximately fifty percent of the interviews were conducted jointly by the researchers with the remaining interviews conducted one-on-one. Each interview was scheduled for one hour with an additional hour allotted if the interviewee wished to continue past one hour. The shortest interview lasted 1.0 hour and the longest lasted 2.5 hours. The average length of an interview was 1.75 hours.

b. Observations.

A number of walk-arounds were scheduled which included product demonstrations. The length and time of these tours varied around the interviews scheduled. Informal discussions were held with creators and managers during these walk-arounds. Additionally, casual

conversation in the cafeteria during lunch breaks also provided a great deal of insight into ACUSON'S culture.

c. Annual Reports.

Annual reports for fiscal years 1986 through 1993 were used for assessment of ACUSON'S financial indicators.

d. Previous Survey.

In July 1993, ACUSON commissioned a continuous improvement survey with the intent of judging Systems Manufacturing's attitude toward quality and continuous improvement. This document provided additional valuable insight into ACUSON'S corporate culture.

e. Peripheral information.

In order to expand our knowledge regarding ACUSON'S Systems Manufacturing and ultrasound use we interviewed people outside ACUSON'S System Manufacturing. We interviewed an ultrasound user and ACUSON employees who were not directly under the Vice President of Manufacturing. These interviews provided valuable information about ACUSON'S Systems Manufacturing and the ultrasound market.

f. Time Frame.

All the data was gathered within a four month period, starting in November 1993 and ending in March 1994. Most of the interviews were conducted within a five week interval during February and March of 1994. In less than a year, ACUSON'S Systems Manufacturing went through: lay-offs, restructuring, implementing "Just In Time" inventory

control, formulating a new strategy, and other related changes. Therefore, the resultant case study represents only a snap-shot of ACUSON'S Systems Manufacturing dynamic journey toward a TQMCS during that time frame.

3. Objective of Case Study

The purpose of this case study is to compare ACUSON'S management control system to the traditional management control system presented in Chapter III, and to the common elements of total quality management control systems as presented in Chapter VII. The analysis uses the continuum developed in Chapter VIII (Table 6). Information gathered on ACUSON'S Systems Manufacturing's MCS was examined in light of each dimension discussed in Chapter VIII. The objective was to place Systems Manufacturing on the continuum illustrated by Table 6.

4. Analysis of Information

Each interviewee's answer to the questions in Appendix C were examined within each of the dimensions. Each dimension was measured on a scale that was subdivided into three areas. The area to the extreme right of the scale represented a TQMCS and the area to the extreme left of the scale represented a TMCS. If it could not be determined from the interviewee's answer if the dimension was TQMCS or TMCS, it was placed in the center of the scale. Further, the location of the answer in the particular area on the scale determined how strongly the answer leaned

towards TQMCS (answer would be rated to the right in that section) or TMCS (answer rated to left of section) (see Table 7). A numerical average was then derived to place ACUSON on the continuum between the traditional and total quality management control systems for each dimension. If observational and other data indicated a more traditional or more TQ approach than the interviews, the authors modified the final placement by no more than one point in either direction.

B. ACUSON'S BACKGROUND INFORMATION

The company was founded by Samuel Maslak, Robert Younge, and Amin Hanafy. Incorporated in January 1982, it announced its first generation ultrasound system, the ACUSON 128, in 1983. The company introduced its second generation product, the ACUSON 128XP, in July 1990. ACUSON went public in September 1986. The stock was originally traded on the NASDAQ but has traded on the NYSE since October 1988.

Since its founding, the company has designed, manufactured, marketed, and serviced medical diagnostic ultrasound imaging systems. ACUSON systems are designed and configured to address the full range of cardiovascular and radiology diagnostic and ultrasound applications. The products are used in cardiology, obstetrics, gynecology, and peripheral vascular examinations. ACUSON sells its systems

in North America, Europe, Australia, and Asia. Foreign markets account for 25% of the company's total annual sales.

Since 1991, prices and profits were pushed down due to a saturated market. As a result, ACUSON laid off approximately 15% of its work force in the spring of 1993. The layoffs were a company-wide policy not a Systems Manufacturing decision. ACUSON'S Systems Manufacturing participated in this difficult process. ACUSON currently employs approximately 1600 employees world wide. Systems Manufacturing employs about two hundred and fifty employees.

The Vice President in charge of Systems Manufacturing (Brad Anker) stated that..."About two and a half years ago, ACUSON'S Systems Manufacturing embarked upon a transformation to Total Quality Management." Initiated by the Mr. Anker the transformation was limited to ACUSON'S Systems Manufacturing. Although, the rest of the company did not join in the transformation, Mr. Anker had the authority and freedom to make the change in his area of responsibility.

As mentioned above, ACUSON'S Systems Manufacturing proved to be a very dynamic organization which has gone through many organizational changes. This high rate of change has resulted in extremely high work loads for management. Managers from all levels are balancing the overload created by trying to manage the changes while also managing the routine day-to-day activities.

As of March 1994, ACUSON'S Systems Manufacturing is organized functionally. The major departments under the Vice President of ACUSON'S Systems Manufacturing are: Production, Test Engineering, Materials, and Production Support and Development. Until recently, ACUSON did not have a "wiring diagram" that described its structure or organization. ACUSON'S Systems Manufacturing is now in the process of defining and formalizing their structure and organization.

C. ACUSON'S SYSTEMS MANUFACTURING MANAGEMENT CONTROL SYSTEM

The dimensions in which ACUSON'S management control system was measured are presented in the following Tables. The dimensions are presented in the same order as in Chapter VIII; dimensions are gathered in groups and the groups are gathered in categories. The numbers in each dimension represent relative placement of ACUSON on the continuum as perceived by the authors. Characteristics of the traditional management control system model, presented in Chapter III, are to the extreme left side of each Table. The common elements of total quality management control systems, as presented in Chapter VII, are to the extreme right. The continuum between the two extremes is scaled from 1 to 9 with 1 being extremely traditional and 9 being extremely total quality. For example: in Table 7, a 9 would indicate that the organization is a total quality

organization while a 1 would indicate that the organization is a traditional organization.

TABLE 7. EXAMPLE OF CONTINUUM BETWEEN TRADITIONAL AND TOTAL QUALITY MANAGEMENT CONTROL SYSTEM.

The Traditional Management Control System	**1 2 3**	**4 5 6**	**7 8 9**	**The Total Quality Management Control System**

1. Mental Model Category:

The mental models stated below are the researchers interpretation of the information gathered in ACUSON'S Systems Manufacturing.

a. Group of Dimensions regarding Planning and Problem Solving.

TABLE 8. THE CONTROL AUTHORITY DIMENSION.

Top Management Controls			9	Self-control

ACUSON'S Systems Manufacturing mental model of "Control Authority" appears to be: "*every member of the organization can, and does control their own processes.*"

Table 8 indicates that creators have "self-control." The researchers didn't find any of the traditional control elements, described in Chapter III, in

place. Creators on the factory floor, like supervisors and managers, controlled their activities. No one was looking over the shoulders of employees to verify that they were doing their work correctly, no one was measured against a quota, and no variances were measured by top management. The pace is set by the planners who determine how many machines should be produced in a given week. Every sub-unit gets its list of production requirements for the coming week. The team leader (the "lead"), in each sub-unit, posts a list of jobs to be completed during the coming week. Every team-member reads the list and prioritizes his or her work accordingly.

The lead is the employee tasked with some of the traditional supervisor's role. The lead spends about half their time on actual production and the other half on paper work and other related activities. The lead does not measure each creator's performance.

In case of an error, the employee discovering the error (usually at the next station in the assembly line) goes back to the employee who made the mistake and asks him or her to correct it. No one records this mistake or reports it to a higher level in the organization.

TABLE 9. THE MANAGEMENT AUTHORITY DIMENSION.

Only Management Manages			8	Authority is Delegated

ACUSON'S System Manufacturing mental model of management authority appears to be: "*each level of the organization has some management authority.*"

Table 9 indicates that each level in the organization has some management authority. Although, creators usually do not participate in deciding what is to be accomplished, they do participate in deciding how it should be accomplished. Managers and creators all mentioned specifically that strategic decisions are not in the area of interest of creators.

Strategic and other decisions are always made using the team process. The Vice President's staff is responsible for strategic and high level decisions. Teams consisting of mid-level managers and creators make operational decisions. Participants in the team process are free to express their opinions and there is little pressure to reach a prompt decision. Team participants representing the various groups are encouraged to bring input from their groups.

The quality focus group is an example of a team which is held in high esteem by its participants. The group consists of various members within the production department and their supervisors. Members bring to the attention of the entire quality focus group quality related issues that have been raised by members of their production groups. The quality focus group has some management authority for acting on these issues, and as an outcome of this group process, suggestions related to these issues are accepted and implemented. Many of the interviewees mentioned this team specifically as an example of an effective team and as a vehicle to promote quality issues. Figure 18 illustrates distribution of management authority in ASM relative to traditional and total quality approaches to management control.

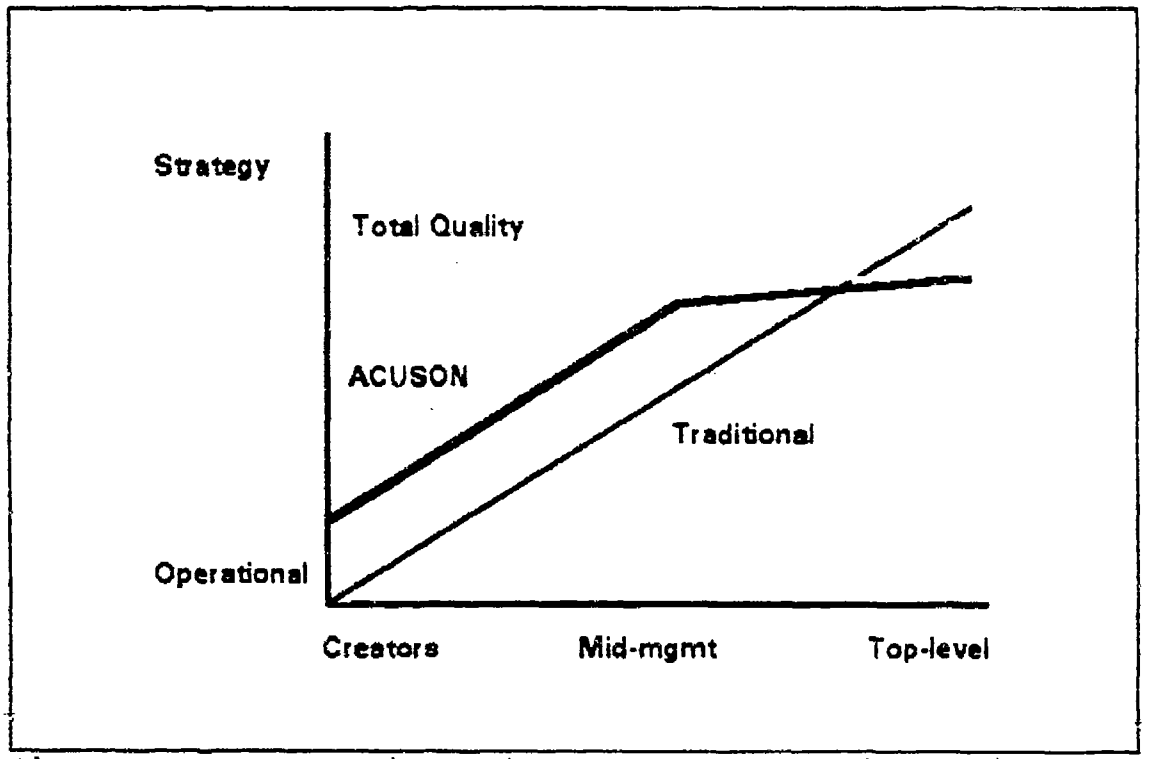

Figure 18. A Comparison of ACUSON'S Degree of Managing and Control Authority that of a TMCS and a TQMCS.

TABLE 10. THE GOAL CONGRUENCE DIMENSION.

Organization is sum of sub-units			7	Organization is greater than sum of sub-units

ACUSON'S System Manufacturing mental model of goal congruence appears to be: *"an organization can achieve more than the sum of its sub-units."*

Table 10 indicates that ACUSON leans towards TQ in the goal congruence dimension. Cooperation between sub-units is encouraged and executed on a day to day basis. For example, if a team needs help, a creator from another team might come into that team to help. The leads of both teams will coordinate this help, supervisors might or might not be notified later. There is no measurement system in place, such as the one mentioned in Chapter III, to measure each unit's performance.

Conversely, a few interviewees specifically mentioned problems between sub-units that hinder cooperation and detract from the performance of the company. In one case, a problem had been detected by interviewees several months in advance of any action taken to resolve the problem. This raises the question of whether or not conflicts are resolved or ignored. Conflict resolution is essential process in the culture of a cohesive TQ company.

TABLE 11. THE PROBLEMS SOLVING DIMENSION.

Emphasis is on Symptoms		5		Emphasis is on Root Causes

ACUSON'S System Manufacturing mental model of problem solving appears to be: "*real problems float to the surface and then are identifiable along with the source of the problem.*"

As indicated in Table 11, the researchers could not identify any organizational system designed specifically for early detection of problems. Usually, processes are not statistically controlled and TQ tools (Appendix A) are rarely used. Problems, such as an unreliable component, are detected intuitively. Once a problem is detected, however, measurements are then taken. These measurements are usually taken as a result of a local initiative by mid-managers or creators.

b. Group of Dimensions regarding People

TABLE 12. MANAGERS' MOTIVATION DIMENSION.

Measurements motivate			8	Managers are motivated

ACUSON'S System Manufacturing mental model of manager's motivation appears to be: *"managers will exercise self-direction and self-actualization toward achieving objectives to which they are committed; this cannot be measured by a short-term quantitative standard."*

Table 12 indicates that managers are highly motivated. Further, it appears that performance measurements are not taken for the purpose of motivating or evaluating managers or creators. Nevertheless, we were able to ascertain through interviews that most managers were highly motivated to accomplish their tasks professionally and to deliver a high quality product. Although people are over-loaded with work, they do their best to meet the needs of the company. The people in ACUSON'S Systems Manufacturing leave a strong impression that they are committed to pursuing ACUSON'S vision (as they perceive it) and to deliver the best quality ultrasound machines.

TABLE 13. THE LINE WORKER'S ROLE IN THE ORGANIZATION DIMENSION.

Only managers are thinkers			8	Workers are also thinkers

ACUSON'S System Manufacturing mental model of the line worker's role in the organization appears to be: *"creators are expected to participate in improving processes and in low level decision making."*

Table 13 would indicate that workers are valued for their ability to think and make decisions for improving the process. The traditional division of roles between management and workers, as mentioned in Chapter III, does not exist in ACUSON'S Systems Manufacturing. Mid-managers and creators retain most of the operational control. Additionally, mid-managers and creators have been delegated with some management authority. However, as stated earlier, creators' input is usually not incorporated into the corporate strategy.

c. The Dimension regarding Information.

TABLE 14. THE INFORMATION DIMENSION.

Individual Performance is Measured		5		Only the Process is Measured

ACUSON'S System Manufacturing mental model of information appears to be: *"it is not yet clear where or what is the essential information for managing and controlling the organizatior."*

Table 14 indicates that ACUSON is in an evolutionary stage for this dimension. The traditional approach to measuring the performance of individuals and sub-units, as described in Chapter III, was not observed in place in ACUSON'S Systems Manufacturing. Conversely, there appears to be no organizational system in place for identifying or gathering process performance indicators. The currently authorized system for collection and measurement of data did not satisfy a majority of the interviewees. ACUSON'S System Manufacturing is in the process of developing a system for the collection and measurement of data that will fulfill the need for relevant information. Until this task is accomplished, it will not

be clear as to what is the essential information for managing the organization.

2. Planning Category

The planning category deals with the dimensions of Vision, Values, Strategy, and Goals and Objectives. The literature shows that every organization has its own definitions for these terms. For the purpose of this analysis, definitions from Chapters II and VII were used for the terms: vision, values, strategy, and goals and objectives.

The researchers found that at ACUSON most of the interviewees could not distinguish between vision, strategy, and goals. ACUSON has a formal statement for vision and values; however, hardly anyone could repeat or knew for sure what the statements said.

The fact that people could not quote the company's definition for values, or any other terms, does not necessarily imply that they do not have shared values. As will be demonstrated later, the authors found that people in ACUSON'S Systems Manufacturing do have shared values, even though, most of them can not quote the official document.

During the period of the case study and survey, ACUSON'S Systems Manufacturing was in the process of developing both vision and mission statements. Management drafted the vision and mission statements, after which,

selected employees had the opportunity to react and suggest corrections.

a. The Dimension of Vision.

TABLE 15. THE DIMENSION OF VISION.

Could have a Vision but will not be Shared		6		Has a Vision and it is Shared

ACUSON'S Systems Manufacturing vision, as interpreted from the collective statements of the interviewees, is to produce the best and highest quality ultrasound imaging equipment in the industry. Many people in ACUSON are strongly committed to this vision, however, a few feel differently. Many of the interviewees could not recite the official vision statement. ACUSON'S official vision statement is:

- ACUSON strives to be the leading world-wide medical ultrasound company, achieving the highest levels of customer satisfaction and long-term shareholder returns.
- Our greatest asset is our people, whose individual and team efforts create innovative contributions with high value for our customers and their patients.
- We pride ourselves in creating a rewarding work environment were all employees share in the timely achievement of these goals.

The researchers overall impression is that people are heavily loaded with work and because of this heavy work-

load they sometimes appear to be struggling for quantity at the expense of quality. Many of the interviewees felt that too much time was spent fighting fires. It is hard to commit to a vision when you are busy fight fires.

Another obstacle in committing to a vision was the recent layoffs. Many of the creators interviewed did not understand the reason behind the layoffs. Some believed that the layoffs actually hurt quality. The authors' impression is that some creators appear to be less committed to quality because of the layoff.

b. The Dimension of Values.

TABLE 16. THE DIMENSION OF VALUES.

Values are Dictated			7	Values are Shared

ACUSON'S Systems Manufacturing formal values are:

- Individual contributions make a visible difference at ACUSON.
- Management's first responsibility is to listen...and then apply some judgement.
- It is critical that people be kept informed of both "what" and "why."
- Team-work is a key element toward success.
- The highest possible standards of quality apply to all aspects of ASM.

However, the values as interpreted by the authors from the collective statements of the interviewees are as follows:

- People are our most important resource
- All levels of the organization should participate in controlling and managing the organization
- Teamwork is a key element toward success

Most of the interviewees felt that these values are shared across the organization. The few vocal exceptions were predicated on the layoff actions. One could expect that an organization's perception of values would affected by such an action. Nevertheless, most creators felt that their managers trusted and respected them. They knew that their opinions did in fact matter and they are encouraged in this belief through participation in team processes. ACUSON'S values in the end seemed to have a stronger effect on creators than the layoffs. For these reasons the authors rated ACUSON a 7 or in the TQ side of the continuum between TMCS and TQMCS, leaning toward the middle.

c. The Dimension of Strategy.

TABLE 17. THE DIMENSION OF STRATEGY.

Strategy is top down	3			Strategy is top down and bottom up

Table 17 indicates that strategy is mostly top down. As discussed in the mental model regarding management

authority in this Chapter, most of the interviewees, creators as well as managers, thought that creators should not take part in the setting of corporate strategies. Managers commented that creators are not interested in this area and that it is not practical to incorporate everyone's input into a sound strategy. Creators were usually happy just to be allowed to participate in controlling processes and making low level decisions. However, there were two exceptions noted by the interviewers.

The first exception was concerning layoffs. The decision as to whether there would be layoffs and who would be laid-off was made at mid and top-level management with no input or consideration from the creators. Creators were not happy with this process. They wished to have had an input into the process.

The second exception was the decision to implement Just-In-Time (JIT). Creators wished they could have influenced whether or not to adopt JIT. Currently creators participate only in the "how to" decisions. They would have liked to have been asked if and when JIT should have been implemented. Many of the creators felt a two to three week delay would have made the transition much smoother. They did not feel that their opinions regarding "if" and "when" to implement JIT were seriously considered.

d. The Dimension of Goals and Objectives.

TABLE 18. THE DIMENSION OF GOALS AND OBJECTIVES.

Goals and Objectives are top down			7	Goals and Objectives are bottom up

Goals, as discussed in Chapter VII, are a means for fulfilling the strategies and to move towards the vision. Goal setting in ACUSON'S Systems Manufacturing, as indicated in Table 18, is mainly a bottom up process. There are differences in how goals are set in the various sections within Systems Manufacturing. Usually, the Vice President's staff will determine goals for ASM, after which, each department staff will develop its goals such that they will be congruent with ASM'S goals. This process continues at the next step down which is the work groups. At the work group level, supervisors and creators together determine the goals for the work group such that these goals will be congruent with the department and ASM goals. Each level in the organization has goals that are congruent with upper level goals and also relates to that particular groups vision. In addition to these goals, people will have personal goals (such as attending a TQ course or other personal growth activities). Personal goals are initiated

by the person and are discussed with his or her manager or supervisor. Most goals are quarterly, however, creators do make suggestions to managers for annual goals which are then mutually agreed upon by both parties.

Managers do not dictate goals to their subordinates. Goals are usually determined by teams and personal goals are initiated by the individual. However, the process of setting organizational goals is partially top-down.

3. The Relationship of Customers and Suppliers Category

a. The Dimension of Customers.

TABLE 19. THE DIMENSION OF CUSTOMERS.

Everyone might know the external customer			7	Everyone will know both external and internal customers

ACUSON'S Systems Manufacturing emphasizes the customer, internal as well as external. Table 19 indicates that people are sensitive to their customers and try hard to satisfy them. They are also interested in feedback from their customers. The current performance evaluation process is an example of their sensitivity to internal customers. Each manager will interview internal customers of a creator before assigning an evaluation to him or her. However,

internal customer satisfaction is not measured systematically. Many of the interviewees mentioned that the current system of customer feedback is "no news is good news" and they expressed concern over the lack of feedback.

Very few people have ever met an ultimate customer or end user of the product. One interviewee mentioned that her friend was imaged by ACUSON'S ultrasound at a clinic and it made her feel very proud of her work. The authors' impression is that people want to measure their customers' (internal/external) satisfaction and they did want to meet and talk with the ultimate customer.

b. The Dimension of Suppliers.

TABLE 20. THE DIMENSION OF SUPPLIERS.

Primarily concerned with measuring cost and quantity indicators		5		Measures quality and builds partnership with supplier

It appears that ACUSON'S Systems Manufacturing has an appreciation first for the quality of supplies and second for their cost. Formal mechanisms for cooperation and partnership between ACUSON and its suppliers is the exception not the rule. However, no system currently exists to measure the quality and variances of incoming materials.

The exception is a project initiated by ACUSON with one of its suppliers in November 1993. The purpose of the project was to create a partnership between ACUSON and the supplier. Engineers, buyers, salesmen, and other personnel from both companies formed a team that meets monthly. The team developed a mission statement which reads as follows: "Develop and implement mutual goals for the continuous improvement of ACUSON'S incoming material."

The team is a means for exchanging information between the two companies. Each meeting starts with a business overview. Representatives from both companies update each other on the latest developments in their companies. Then, they deal with action items from previous meetings. The team also develops statistical measurements for the purpose of measuring and rating suppliers. As stated earlier, this example is the exception to the rule. However, the fact that such a project exists, indicates that ACUSON is ready to form partnerships with other suppliers.

4. The Measurements Category

TABLE 21. THE DIMENSION OF MEASUREMENTS.

Only financial criteria is measured		6		Non-financial criteria is also measured

Table 21 indicates that ACUSON'S Systems Manufacturing does not measure financial criteria nor does it use performance measurements to motivate people in the manner of traditional management control (see Chapter III). When information is collected, the people actually doing the work act on that information. As a whole, people were not usually defensive concerning measurement. For example, when asked if it would be useful for them to measure their errors, most replied they would like to have such a measurement.

ACUSON'S Systems Manufacturing does not appear to have a useful systematic method for measuring processes. The perception of reality is mainly intuitive. The measurements in use, such as "DOA'S" do not satisfy the needs of the creators, managers, or ASM. Further, routine measurements mandated by ACUSON usually are not taken seriously as mentioned by most of the interviewees. Several of the interviewees felt that the current system does not emphasize root causes.

An example of their approach to measurements is the periodic individual performance evaluations. Managers evaluate their subordinates against a set of criteria. The rating an employee receives determines what merit increases the employee will receive. One of the criterion is performance objectives or results achieved (taken from an ACUSON appraisal form). Most managers allow their

subordinates to determine their own objectives. And, as discussed in the customer dimension in this chapter, most managers ask for feedback from their subordinate's internal customers. Different managers complete the appraisal differently. Most managers were not happy with existing appraisal system. One idea expressed by a manager was that the employees should interview their own manager and customers, after which, the employee would write their own appraisal.

Another example is the DOA. DOA is the acronym used for defects in machines received by customers. A DOA can mean anything from a missing book to a completely inoperative machine. Only problems that occur or are discovered within two weeks of the machines arrival at destination are counted as DOA. DOA'S are measured and reported on a monthly basis. Many interviewees felt that measuring only problems that occurred in the first two weeks after delivery did not serve the purpose of improving the process. Furthermore, the interviewees mentioned that reporting DOA'S on a monthly basis is meaningless because there is no correlation between the time a machine is constructed and the time it is delivered.

The authors' impression is that ASM does not use either the traditional or total quality methods of measurement. This impression is supported by numerous comments made by interviewees.

5. The Control Practice Category

TABLE 22. THE DIMENSION OF CONTROL PRACTICES.

Decisions are made only at the highest level			8	Decisions are made at the working level

Table 22 indicates that most decisions regarding control are made at the working level. ACUSON'S Systems Manufacturing perception of control is nearly identical to those of the Total Quality Management Control Systems models in Chapters V and VI. The main difference is that although people are not controlled, processes are usually not controlled either. The individual owning the process has control of that process. Operational decisions are made as close as possible to the process. People throughout ACUSON feel good about this control practice. The overall impression of the researchers is that although people are heavily loaded with work, they remain committed to ACUSON and that this delegation of control is an essential element in generating total commitment under the current work-load.

6. The Benefits Category

TABLE 23. THE DIMENSION OF BENEFITS.

Appreciates primarily the end result of an individual work		6		Appreciates team effort

Table 23 indicates that ACUSON is neither traditional or total quality in the benefits category. Incentives or benefits at ACUSON, are primarily in the form of "merit increases" (previously discussed in measurement category, section 4) and are given in the form of special bonuses (from fifty to three thousand dollars as determined by managers). Other special recognition (like free dinners) is also given by managers to creators and at ACUSON'S expense to reward employees. Benefits are usually given as a recognition for past activities and not for the purpose of motivating people.

However, merit increases and bonuses or recognition are usually given to individuals, not teams. The performance evaluation form used at ACUSON also tends to emphasize individual contribution. There is no formal system for peers to give each other formal recognition nor is there any process or system whereby teams are evaluated. One of the interviewees mentioned that the current system

does not appreciate people who contribute to the team as much as it does people who have made impressive individual achievements. ASM benefits are unlike traditional since there are not directed at motivating people and are not distributed according to end results, however, they are not like total quality because they tend to de-emphasize team effort.

7. **Information flow Category**

TABLE 24. THE DIMENSION OF FREEDOM OF INFORMATION FLOW.

Vertical upward flow of information only			8	Free flow of information vertically and horizontally

The research indicates ACUSON'S Systems Manufacturing encourages the free flow of information. Generally, information is not used as a source of power but as a resource for its users. Creators communicate directly with creators in other departments and work areas. It is not necessary for creators in separate areas to communicate through a common manager. Team leaders coordinate activities and solve problems among themselves. However, although information flows freely throughout the organization, several interviewees mentioned specifically

that management does not always provide employees with general information. For example, a detailed explanation of the reasons for the layoffs were not given at the time. Another example was a case in which a new employee was about to start work and no one in that new employees team had been informed of the new hire.

Recently a communication team was formed. The team members consist of the V. P. of Systems Manufacturing, two of his staff members, and several creators. The purpose of the team is to identify what information people want management to provide.

TABLE 25. THE DIMENSION OF FIRST-HAND DATA COLLECTION.

Accomplished intuitively		4		Accomplished systematically

As discussed in Chapter VIII, both traditional and total quality management control systems use first-hand informal data collection methods to gather important information. Total quality organizations tend to collect informal data more systematically, while traditional organizations tend to be more intuitive towards collecting informal data. A majority of creators interviewed mentioned that they seldom see their supervisors and managers since they (supervisors and managers) are always in meetings. One

manager interviewed corroborated this opinion. For these reasons, ACUSON'S Systems Manufacturing data collection currently appears to lean toward the traditional approach.

D. CHAPTER SUMMARY

ACUSON'S Systems Manufacturing management control system is in transformation from traditional to total quality management control practices. Table 26 summarizes the positioning of ACUSON'S Systems Manufacturing management control system relative to the total quality management control practices described in Chapter VII.

TABLE 26. A SUMMARY OF ACUSON'S CONTROL SYSTEM RELATIVE TO TOTAL QUALITY CONTROL PRACTICE.

DOMAIN DESCRIBED	ACUSON RELATIVE TO TQ IN DOMAIN
Control Practice	• Identical to TQ practice
Management Practice	• Decisions are made by teams • Decisions are made at the level that actually does the work • Creators are not participating in strategic decision making
Measuring	• Practically no measurement systems are in place • ACUSON does not use the traditional system and has not yet developed a substitute
Information flow	• Information flows freely horizontally and vertically

Table 27 summarizes by dimension ACUSON'S relative positioning on the continuum between traditional and total quality management controls systems. It should be emphasized that this placement was a subjective, qualitative, assessment by the authors, and is only intended to highlight possible areas for change or improvement.

TABLE 27. SUMMARY OF ACUSON CASE STUDY BY DIMENSION

DIMENSION	TRADITIONAL	123	456	789	TOTAL QUALITY
1. CONTROL AUTHORITY	Top-management Controls			9	Self-control
2. MANAGEMENT AUTHORITY	Primarily management manages			8	Management authority delegated
3. GOAL CONGRUENCE	Organization equals sum of sub-units			7	Organization greater than sum of sub-units
4. PROBLEM SOLVING	Emphasizes symptoms		5		Emphasizes root causes
5. MANAGERS MOTIVATION	Enhanced by measurements			8	Managers are motivated
6. WORKERS' ROLE	Management thinks, workers do			8	Workers think and work
7. RELEVANT INFORMATION	Individual's performance		5		Processes' performance
8. VISION	May have a vision		6		Shared vision
9. VALUES	Dictated values			7	Shared values
10. STRATEGY	Top down strategy	3			Top down and bottom up
11. GOALS and OBJECTIVES	A top down process			7	A bottom up process
12. CUSTOMER	Ultimate customer			7	Internal and ultimate
13. SUPPLIERS	Cost, quantity and schedule		5		Partnership
14. MEASUREMENTS	Financial criteria		6		Non-financial criteria
15. CONTROL PRACTICE	Individuals controlled by manager			8	Individuals control self
16. BENEFITS (given for)	Individuals end results		6		Team's effort
17. INFORMATION FREE-FLOW	Vertical flow of information			8	Horizontal and vertical flow
18. FIRST-HAND DATA COLLECTION	Done intuitively		4		Done systematically

X. CONCLUSION AND RECOMMENDATIONS

This chapter provides recommendations for ACUSON and answers the four research questions introduced in Chapter I. The conclusions reached are based on knowledge gleaned from an extensive review of current literature, the case study of ACUSON Corporation, and the authors' combined experience in the military environment.

A. RECOMMENDATIONS FOR ACUSON'S SYSTEMS MANUFACTURING

ACUSON'S Systems Manufacturing has made enormous progress towards a total quality culture. Most impressive is ACUSON'S attitude towards its people and the empowerment that creators and managers enjoy. This achievement is essential to future progress in ACUSON'S transformation to a fully functional total quality culture. The following recommendations are made in an effort to fine-tune an already impressive start. All recommendations are given under the assumption that ACUSON'S Systems Manufacturing desires to continue their transformation towards a total quality culture.

1. Define of Mission, Vision, Values, Strategy, Goals, and Objectives

As discussed in Chapter IX the terms vision, values, strategy, mission, goals, and objectives are not all well

defined in ACUSON'S Systems Manufacturing. The authors recommend that:

- ASM clearly define these terms and communicate the definitions company wide. Once these terms have been defined then assess current definitions and make changes as necessary. Creators and managers should all contribute to the process of defining the terms and developing the vision and mission statements.

2. Develop Method for Incorporating Creators' Input into the Strategic Decision Making Process

As described in Chapter IX, creators' inputs are not usually incorporated into strategic decision making. As discussed in Chapter VII, creators will more readily commit to a vision, mission, values, or strategy if they are truly shared or if they feel ownership of them. In order to create shared vision, strategy, and values, it is recommended that:

- ACUSON develop a method for incorporating creators' input into the strategic decision making process. Canon's "catch ball" process as defined in Chapters V and VI is one possible method to use.

3. Use Systematic Measurements

ACUSON'S Systems Manufacturing is in the process of developing a set of measurement criteria that will be useful to the organization. It is recommended they:

- Use the systematic measurement approach and tools in Chapter VI and Appendix A for identifying and collecting data for process improvement.

Process owners should measure their customer's (internal or external) satisfaction. One creator might measure satisfaction of the next creator in the assembly process. Supervisors should measure the satisfaction of the

next team in the assembly process and so on until finally the ultimate customer's satisfaction is measured. Many creators mentioned that the current feedback system was "no news is good news" and "a quiet customer is a satisfied customer," and that they usually do not receive any feedback when they do a good job. The researchers impression is that creators are willing to measure their customer satisfaction and to measure their own processes. For example, many creators wished to measure errors that they were responsible for. This approach will only work if creators do their own measurement and keep the records regarding their performance. No measurement system will truly reflect reality if creators feel that *management* measures their performance. Measuring customer satisfaction will fulfill creators' need for feedback and will also improve quality (see Chapter VI, section C).

4. **Tracking Parts and Material**

It is recommended that ACUSON'S Information System be used to:

- Track all parts and material from receipt to end of life.

All parts should be tracked whether they are in the stockroom, assembly-line, installed on a machine, or pre-positioned with field engineers. Defective parts should be recorded in the manufacturing process and when field repairs are completed. This data would increase the

reliability and quality of ACUSON'S products by identifying early trends for defective parts and material.

5. Reconsider DOA Policy

Currently, much emphasis is placed on DOA'S. It is recommended that:

- ASM reconsider its DOA policy.

In the present policy, only problems that occur or are discovered within the first two weeks after delivery are measured as a DOA. From the ASM'S point of view, it should not matter if a problem was discovered by the next person on the assembly-line, before shipping, one week after delivery, or five years after delivery. If the goal is to deliver a defect-free machine, then measurements should be taken and acted upon throughout the whole process of manufacturing and life cycle of that machine and not just in a two week period of time after delivery of the machine.

DOA's are currently measured as a percentage of machines installed in a specific month. For example, in July the DOA rate was one percent (one of every hundred machines delivered in July had one or more defects). Machines that were installed in July might have been manufactured in January, March, or June.

Additionally, machines arriving at the customer's site are counted as DOA if they are defective. A machine could have one or ten defects but it would only count as one DOA.

Many interviewees criticized the current DOA measurement method. Their three main points were mentioned above. Therefore, it is not clear that DOA as a control measurement of failure rate is meaningful. The authors also feel that measurements should be of success rates (positive) and not of failure rates (negative).

6. Retaining Services of Professional Statistician

Identifying what to measure and the tool to measure it is a complicated process, often requiring the services of a professional statistician. Further ACUSON is evolving in the area of process measurements. Therefore, the authors recommend that:

- ASH should consider retaining the services of a professional statistician (see Chapter VI, sections C through O for further justification).

A statistician would assist process owners in identifying what should be measured and the tools to use, and in maintaining statistical controls.

7. Apply Supplier Relationship Model

Adopting a measurement system requires much training and other expenditures and expense such as labor hours, costs of training, and lost production, nevertheless, the authors believe the actual benefits are high and will outweigh all costs in the long run.

Supplier relationships are important to total quality organizations. The authors recommend that:

- ASM apply their supplier relationship model described in Chapter IX to as many other suppliers as possible.

8. Establish Systematic Method for Implementing First-hand Data Collection

First-hand data collection is an informal means of gathering information and is similar to the "doctors rounds" described in the Canon model, Chapter V. Managers collect information or data directly from creators, customers, suppliers, and other sources first-hand. This method of data collection consumes much more time than simply reading formal reports. But, unique information that might not otherwise be accessible can be obtained. Additionally, a by-product of this method of data collection is the good-will fostered as a result of the close personal contact by managers with creators, customers, and suppliers. People in and out of the organization will appreciate this method of data collection because of this close personal contact. It is recommended that:

- ASM'S managers establish a systematic method for implementing first-hand data collection or doctors rounds with creators, suppliers, customers, designated groups, and other individuals.

9. Use of Performance Evaluation for Determining Merit Increases

Chapter IX describes ACUSON'S performance evaluation method. Most managers expressed dissatisfaction with the existing system. It is recommended that:

- ASM not use performance evaluation for determining merit increases in pay. Further, it is recommended that ACUSON consider the performance evaluation process suggested by one ACUSON manager.

That suggestion is as follows: let the evaluated person do the work. The evaluated person would interview his boss, his customers, his team peers and then write their own performance evaluation, after which, they would then discuss this evaluation with their manager. The evaluation would be filed by the evaluated person and only he or she would have access to the evaluation. Performance evaluations which are completed by managers and recorded in the company files detract from morale and are usually not an accurate reflection of the evaluated individual's true performance. The suggested process is a learning process for the creator and will help them to continue growing professionally and intellectually.

10. Workload

Most of the interviewees, both managers and creators, mentioned that management is heavily loaded. Many mentioned the term "fire fighting" in relation to the manager's daily routine. Additionally, the rate of organizational change is very high. Hence, many of the creators mentioned that they do not get to see their supervisors and managers. It is recommended that:

- ASM'S management consider the workload on managers, determine if it can be reduced or delegated in order to allow the manager more time to spend with his or her process and creators.

B. IMPLICATIONS FOR DOD, DON, AND OTHER AGENCIES

Chapter III describes a military management control system. The military management control system is a TMCS, however, the United States Navy is making a conscious effort to transform itself into a total quality culture (see Chapter I). Therefore, the question of whether or not a military organization can effectively use a total quality management control system is of pressing importance.

Chapter III describes mental models commonly held by traditional management control systems while Chapter VII describes total quality management control systems' mental models. These Chapters show a strong correlation between the type of MCS in use and the mental models behind them. When an organization has a TMCS it implies that organization holds a set of traditional mental models. If, on the other hand, an organization has a TQMCS it probably holds a set of TQ mental models. However, it is theoretically possible that an organization holding traditional mental models could have a TQMCS. It is also possible that an organization holding TQ mental models could have a TMCS. Lets examine this possibility.

For example, if an organization holds the traditional mental model "only top-management controls the organization," would it be possible for it to have a TQMCS? Will managers who hold this mental model delegate management authority to low-level managers and creators? The authors

assert that if a manager holds this mental model he will not delegate control authority making it impossible for creators to control themselves. Hence, managers who hold to this traditional mental model would be reluctant to adopt a system that they perceive will take away their authority.

Based on this example and the definition of mental models given in Chapter I, one can conclude that a manager who holds traditional mental models will not adopt a TQMCS.

We have shown the military, like any organization with a TMCS, will of necessity hold to a set of traditional mental models. Since the military does hold a set of traditional mental models, it can not use a TQMCS unless it changes its mental models.

Consequently, the problem facing military organizations is not one of whether or not a total quality management control system is adaptable to the military, but rather, one of whether or not the military will discard its traditional mental models and adopt total quality mental models. Any organization that holds to total quality mental models can and will transform towards a total quality management control system. Examining how the military can change its mental models related to management control systems is beyond the scope of this thesis. Therefore, the questions of "Can or should the military transform itself into a total quality culture and use a total quality management control systems?" are beyond the scope of this thesis.

C. CONCLUSIONS AND ANSWERS TO THE RESEARCH QUESTIONS

1. What are the commonly held mental models that form the foundations of both types of Management Control Systems?

Management control systems are not stand alone mechanisms. Each organization, whether traditional or total quality, develops its own management control system in which is rooted the mental models of its culture, see Chapter VIII. However, there are common elements for both the traditional management control system (listed in Chapter III) and the total quality management control system (listed in Chapter VII). These common elements were previously discussed in the above Chapters.

2. What is a Total Quality Management Control System?

No one model can be used to describe a TQMCS. The authors were limited to identifying the common elements of a TQMCS, and these were described in Chapter VII.

3. What are the similarities and differences between the Traditional and Total Quality Management Control Systems?

Chapter VIII compared traditional and total quality management control systems, illustrated in Figure 25. The dominant difference noted is that while in total quality management control systems creators and managers primarily control processes, traditional management control systems are used by managers to control their subordinates.

D. SUMMARY

Both traditional and total quality management control systems are a product of the mental models held by the organization. A management control system is simply a tool that management uses. Therefore, management control systems are inseparable from the culture of the organization. Traditionally, management control systems lay within the purview of the accountants. However, total quality management control systems are in the purview of managers and creators not the accountants. Furthermore, the discipline of "management control systems" is not as well defined in the total quality management literature as it is in the traditional literature. One possible reason is that people in the total quality culture perceive control as an integral part of process management, whereas, traditionalists view control as mainly a financial tool used by management for controlling the people's actions.

E. RECOMMENDATION FOR FUTURE STUDY

Based on the research conducted in this thesis, it is projected that the traditional mental models held by military organizations will be the principal hinderance to transforming the military into a total quality culture. The

authors recommend future study of the following topics regarding this area:

- Are the mental models surrounding management control in the total quality culture usable by military organizations?
- If a transformation to a total quality management control system is desired, then what strategies can be used to create new mental models?

APPENDIX A

MEASUREMENT IN A TOTAL QUALITY MANAGEMENT CONTROL SYSTEM

A. MEASURING FOR CONTROL

You can't control what you don't measure (Globerson, 1991, p. ix), hence, in a total quality management control systems measurements must be taken and plotted. The ensuing plots or charts will aid managers and creators in determining if a process or system is stable or unstable (Deming, 1992, p. 194).

Knowing if a system is stable or unstable requires an understanding of variation. To properly evaluate measurement charts, criterion must be established as a basis for comparison. A relevant measurement criteria is a indicator that can be used to discern improvement or deterioration in organizational process (Globerson, 1991, p. 30).

The use of measurements in a total quality management control system is solely for the purpose of determining statistical control and furthering continual improvement. It should not be construed as quotas, management by numbers, management by objectives, or numerical goals. Measurements are used for process improvements not as tools for evaluating managers or creators.

B. DETERMINING WHAT TO CONTROL

Determining the list of processes to control begins with three questions: First, what does the customer want and need? Second, what is the cost of an undetected error? and Third, what is the cost of controlling an error within a process?

Before a decision is made to control a process it is necessary to first consider what effect controlling that process will have on the customer. Will it be of benefit to customers or will it be contrary to the customers' wants and needs?

Some errors are easily quantified, but others, such as errors that damage the reputation of an organization, may be difficult to quantify. The cost of an error must be known because the benefit of controlling an error must in the long run outweigh the cost of controlling it (Globerson, 1991, pp. 21,22).

There are a number of different types of process measurement criteria that can be charted or monitored for control. But not everything should be subject to control; the organization must limit itself to a manageable number of measurement criteria. Otherwise, the organization is liable to create a system which ignores important items (items that effect product quality, cost, and delivery) and exerts too much effort in examining others (items that are not material to product quality, cost, or delivery) and will become

burdensome to the point of becoming meaningless to both managers and creators. (Globerson, 1991, p. 20) While there are no hard and fast rules as to the correct number of measurement criteria to be used in any one process, at least one theorist recommended that organization focus on not more than seven key measurement criteria (Globerson, 1991, p. 44).

C. LEVELS OF CONTROL

There are three levels of control in any organization. The levels are strategic, tactical, and operational (Globerson, 1991, p. 25).

The strategic level of control focuses on policy and planning. the tactical level of control focuses on the organization's decisions and how they are carried out. The operational level of control deals with the mechanics of what is produced for the customer.

D. TIMING OF CONTROLS

Timing is a critical component of control. If control is applied to any process without an understanding of timing and variation the results can be catastrophic. For any given process when and how often to apply control is variable. Control can be pre-process, in-process, or post-process.

One must consider that..."There are many processes where the people can and do affect the outcome, but chaos can occur when those people use inappropriate methods to try to affect the outcomes (Sherkenback, 1991, p. 41)." Dr. Deming refers to this as tampering.

In the funnel experiment, Dr. Deming demonstrates that if anyone adjusts a stable process trying to compensate for a result that is undesirable, or for a result that is extra good, the output that follows will be worse than if he had left the process alone (Deming, 1986, p. 327). Before adjustments are made to any process, it is necessary that the process be in statistical control. If we tamper with the process we may not get to where we want to be. To quote an old Chinese proverb, "If we don't change our direction, we may end up where we are heading" (Camp, 1989, p. 273). Once the process is in statistical control, one may then decide on the basis of engineering and economics whether any adjustment at all is desired. (Deming, 1986, p. 331)

E. SELECTING MEASUREMENT CRITERIA IS A TEAM PROCESS

Selecting process measurement criterion, for charting and controlling, is a team effort in the total quality management control system. Quoting Confucius, "Tell me and I forget, Show me and I remember, Involve me and I understand." Employee commitment [empowerment], alias employee involvement, participative management, team

building, employee motivation, and sense of ownership (Brocka, 1993, p. 138), is a critical component in total quality management control systems. The team concept is just one way for fostering employee commitment. Additionally, a team can combine individual talents and abilities to become an effective and cohesive unit that is able to conquer otherwise insurmountable problems.

Before selecting measurement criteria it is a good idea for the team to review the organization's mission and vision statements. The are a number of processes a team can use to selecting the right process to measure and control. How a team selects what to measure is discussed in section H of this chapter.

F. CATEGORIES OF MEASUREMENT CRITERIA

There are essentially two categories of measurement criteria: vertical and horizontal. Vertical measurement criteria are those used in evaluating the performance of an organization as a whole, such as production, marketing, purchasing, personnel, or financial. Horizontal measurement criteria are those used for the evaluation of processes.

A process may begin and end in one department or division, or it may involve numerous other departments or divisions either internal or external to the organization, such as customers and suppliers. In either case, it needs horizontal measurement criteria. (Globerson, 1991, p. 31)

Horizontal measurement criteria may further be subdivided into process and resource measurement criteria. Resource measurement criteria deal primarily with equipment, infra-structure, capital, and are usually limited to the organization. Process measurement criteria are not limited to the organization.

G. FACTORS AFFECTING MEASUREMENT CRITERIA

The list of feasible measurement criteria is infinite, however, it can be reduce to a manageable number by considering certain factors.

Factors that must be considered are: the customer's wants and needs, the organization's objectives, clarity of purpose, objectivity, reliability of measurements, calculation methods, and does the criteria measure what you want it to measure (Globerson, 1991, pp. 39-42).

The customer is the ultimate judge of quality (Imai, 1986, p. 207). Hence, establishment of process measurement criteria will always begin with the customer. The total quality management control system will aid the organization in reaching its goal of meeting and exceeding the customer's needs and give the customer a product that has lasting value. (Scholtes, 1991, p. 1-11). Focusing on the customer's needs is the greatest factor affecting measurement criteria. Customers are not always external, customers can also be internal to the organization.

The objectives of an organization must support the mission and vision statements. If an organization's objectives are not in harmony with its mission and vision statements, it will be impossible to pursue and obtain improvement in any process. Measurement criteria must support the organizational objectives which in-turn must also support the organization's mission and vision.

Clarity of purpose is very important to the selection process. If the purpose of the criteria cannot be quantified then the interpretation of the measurement will be meaningless. For instance, the criteria, high morale, cannot be quantified without further clarification. Precise and measurable criteria such as tardiness, absenteeism, and employee turn-over rates must be used.

Total quality management control systems require objective and reliable data for decision making. If data is subjective, the decisions based on that data will most likely be in-efficient. Selected measurement criteria must be objective and relevant to the process.

Measurement criteria are often chosen for the wrong reasons. It will be tempting to choose measurement criteria that are easily gathered and measured, however, the most easily accessible criteria may not contribute to improving the process, and, in fact may cause decisions to be made that will be detrimental to the process. For instance, imagine a customer service hot line where the measurement

criteria is how quickly the calls are handled. On a control chart it may appear as if all is well, but a customer who receives a quick and un-polite answer might perceive it differently.

H. SELECTING AND PRIORITIZING CRITERIA

The first step in selecting and prioritizing measurement criteria for a specific process is creating customer, supplier, and employee involvement. All customers, suppliers, and employees, no matter how close or distant to the process, may have ideas related to improving the process. These ideas will form the initial list of potential measurement criteria.

After the initial list has been compiled, it should be given to the process improvement team for that specific process. The process improvement team considers all the factors affecting the initial list of measurement criteria and generates a refined initial list of measurement criteria.

Finally, the process improvement team should apply the rule of seven, further reducing the refined initial list to approximately seven relevant process measurement criteria. This can be accomplished by having each team member assign a numerical weight to each of the measurement criteria and then calculating a weighted average for each criteria on the

list. The seven criteria with the highest averages are used for used for process measurement. (Globerson, 1991, p. 44)

I. SETTING STANDARDS FOR CRITERIA

Once an organization has determined which measurement criteria it will use to evaluate a process, it must then set specific measurement standards. Upper and lower statistical control limits must be established for each measurement criteria. There are various methods for setting these standards, however, the choice of method is greatly dependent on the nature of the organization and the process. (Globerson, 1991, p. 53)

For the military, the standards are often contained in military specifications or other regulatory requirements but the bottom line is "what does the customer want and need." Hence, milspecs or other written standards in and of themselves are not enough for setting standards, the team must have customer, supplier, and employee input.

J. USING STANDARDS FOR MEASUREMENT CRITERIA

Often, there is a gulf between the expectations of an organization and reality. It will be tempting to close this gulf by placing additional pressure on the creators. Quoting Dr. Deming, "you can beat a horse and make him run faster, for a little while." (Deming, 1991)

In the total quality management control system, standards for measurement criteria are used for process improvement not for beating the horse. Standards for measurement criteria can be used to support performance agreements between managers and creators. A performance agreement is not a job description. It is, however, a win-win contract established through a process of synergistic communications between managers and creators to aid in focusing on both the organization's and individual's mission and vision. (Covey, 1992, pp. 206-208)

E. MEASURING CRITERIA

A major problem in any management control system is that data collection often is not considered to be productive work. It is frequently viewed as extra or not part of the necessary activities of an organization. Consequently, the task of data collection is often the first to go when organizations become constrained by money or time. This is true even though the lost information may have pointed the way to more effective operations. (Globerson, 1991, p. 74) Because of this, data collection in a total quality management control system must be considered an integral part of each process improvement team's tasking. The use of computers will greatly reduce the labor required and improve the accuracy of calculations.

Any manager [or process improvement team] should plot points for activities of interest that have been decided upon (Deming, 1992, Appendix 18). The following examples are not all-inclusive but represent a sampling of areas in which important measurement criteria might be identified:

- Absenteeism
- Accidents
- Equipment Breakdowns
- Customer Complaints
- New Customers
- Administrative Cost
- Waste or Scrape
- Travel Cost

L. TOOLS FOR MEASURING CRITERIA

The total quality management control system requires tools for measuring. There are a large number of available tools, but this thesis has focused only on the seven basic statistical tools presented in Chapter V. For a more comprehensive presentation and examination of statistical tools the readers is referred to Scholtes' Team Handbook, Chapter II and Ishikawa's *guide to quality control.*

There are numerous measurable and not-so-measurable criterion. While the measurements themselves are physical, what they measure can be either physical, logical, or emotional (Scherkenbach, 1991, p. 142). Process measurement criterion might deal with people, methods, material, equipment, or environment. Therefore, the required tool will vary with the process and criteria being measured. In either case, the main purpose of a tool is to visualize the

process in order to pinpoint the problem so that the causes can be isolated and solutions worked out. Tools also provide a way to evaluate proposed changes. (Scholtes, 1991, p. 2-18)

The tools used for process improvement may appear deceptively simple. But most teams will need a statistician's help in the early stages to choose the appropriate tools and know when and how to use them (Scholtes, 1991, p. 2-18).

M. APPLICATION AND USES OF THE SEVEN BASIC TOOLS

Before one can attempt to improve a process they must have stable statistical control over that process. In the following scenario it will be demonstrated, using the Deming Plan-Do-Check-Act (PDCA) cycle, and the appropriate tools, one method for establishing statistical control over a specific process. At this point, it is important to remember that removal of special causes to bring a system into statistical control is not process improvement. Process improvement is difficult and complex but its aim is simple, shrink the gap between the upper and lower control limits (Deming, 1986, p. 338). By establishing and using measurement criteria one can identify common causes and take the appropriate actions to narrow the gap between the upper and lower limits of the control chart.

Although there are a number of methodologies that might be used for solving a given problem, the King six step method will be discussed here (King, 1989, p. 3-3). This method involves a sequential progression through the Deming PDCA cycle.

Suppose that Southern Expose' (SE) is an old line retail company that sells a broad range of consumer goods to a homogenous population of graduate students attending the nation's most prestigious military postgraduate school.

SE'S mission is to provide quality goods at affordable prices, to have in stock the right merchandize at the right time, and to provide quick and friendly service. SE'S vision is to win the prestigious Golden Smile award for being the best retail outlet in the entire system. SE uses a total quality management control system.

In an effort to improve customer service, the store manager mailed a number of survey forms to the residents of campus housing. These survey forms were designed to be easily completed in just a few minutes. Additionally, self-addressed stamped envelopes were also provided for the customer's convenience. Basically, customers were asked to choose one of six possible areas for improvement.

After the forms were returned to SE, the process improvement team assigned to this project proceeded as follows:

Step one, decide which customer service initiative to address first. Using a Pareto chart, the process improvement team was able to ascertain that the number one customer concern was length of check-out lines and the time lost waiting in line.

Step two, describe the selected problem in specific terms, what, when, where, and to what extent. Once the specific problem has been described, the process improvement team may used a run chart, for trend analysis. Using the information from the run chart the team concluded that the problem only exist at certain times of the day and only on certain days.

Step three, frame the problem and all possible causes. Using a fishbone diagram, the process improvement team grouped all potential causes (methods, machinery, personnel, or material) by categories.

Step four, pinpoint the most probable cause. After having framed the problem, the team gathered more specific data relevant to the problem. Using this data (such as required number of cashiers for projected number of customers) and a scatter diagram, they identified the basic cause to be a shortage of cashiers at peak hours (eg; lunch or immediately following the last bell on campus).

Step five, develop and implement a solution. The process improvement team had all the information needed to design and implement a solution. In this scenario the team

chose to cross train floor clerks as cashiers to operate cash register during the peak periods.

Step six, monitor the solution. The control chart is the tool most used for establishing and maintaining statistical control over a given process. The information on the control chart is the process talking to us (Deming, 1986, p. 333). A control chart tells us where a stable system is today and where it will be next week or even next year. Control charts are also used to maintain statistical control of a process that is already stable (Deming, 1986, p. 337). In this scenario the process improvement team used the control chart to gain statistical control over the process and then they continued to monitor it to maintain that stability.

N. SUMMARY

In this Appendix it was presented, with exegesis as to their significance, information that must be considered when implementing measurements in a total quality management control system. It was illustrated that in a total quality management control system, managers and creators measure to control. Factors that affect measurements and the selecting of criterion standards for measurement control were also discussed. The Appendix was closed with a presentation of a fictional application of the seven basic tools.

APPENDIX B

LETTER OF INTRODUCTION FOR INITIAL ENTRY

SMC 1600
Naval Postgraduate School
Monterey, Ca 93943
October 25, 1993

Mr. Pat McMahon
ACUSON Corporation
1220 Charleston Rd.
Mountain View, CA 94039

Dear Mr. McMahon,

Per our discussion, I am submitting the following introduction prior to our scheduled meeting.

My colleague and I are graduate students at the Naval Post Graduate School (NPS), Monterey, CA. in the Financial Management curriculum. We would like to conduct a case study of ACUSON'S Management Control System (MCS). We believe that ACUSON'S MCS promotes initiative and creativity allowing ACUSON to explore new opportunities through an empowered work force. During these times of austere defense budgets it is imperative that military managers be effective and efficient in the conduct of their duties. We believe that ACUSON has a proven and successful MCS from which our respective services (Israeli Air Force and U. S. Navy) may learn much. ACUSON'S MCS will provide valuable insight for the Quality Focused Military Manager.

Lieutenant Colonel Cohen is a pilot in the Israeli Air Force. He has twenty years experience in combat aircraft, mostly the Cobra gunship and of late the Apache helicopter. Colonel Cohen commanded two combat squadrons before assignment to NPS. After graduating NPS in June 1994, he will be promoted to full Colonel and posted to the Israeli Air Force headquarters.

Lieutenant Commander Haney is a Supply Officer with twenty-six years naval experience (twelve years commissioned experience in Logistics and Finance and fourteen years experience as an enlisted Electrical/Electronics Technician on naval aircraft). Before reporting to NPS LCDR Haney was the Supply Officer (Supply Department Head) onboard the USS El Paso, a Combat Cargo Ship, where he was instrumental in beginning Dr. Deming's Total Quality Management style. LCDR Haney will transfer to Washington, D.C. for duty upon graduating NPS in June 1994.

We sincerely appreciate the consideration you have given our thesis project. We look forward to meeting you 9 Nov, at 2 pm. Our respective telephone numbers are; NPS FAX 656-2138, COL Cohen 655-3066 Hm, LCDR Haney 375-1539 Hm.

APPENDIX C

ACUSON CORPORATION
CASE STUDY INTERVIEW FORM

Date:

Department:

Creator (optional):

A. Introduce ourselves:

1. Students NPS, US Navy and IAF.

2. Conducting research on management control systems.

3. ACUSON selected as model for case study.

4. Promise of Confidentiality: Unless specificly authorized by the interviewee, no information divulged in this interview will be transferred or given to any other person in or connected with ACUSON Corporation. The only information that will be published, and made available to ACUSON Corporation, is a general summary of everyone's answers.

B. Job description:

C. Question regarding shared vision and values.

1. What is the purpose, vision, and mission, of:

ACUSON?

Systems Manufacturing?

Your Department?

Your group?

Yourself?

2. Who set this vision and values?

3. Were your inputs incorporated in the organization's mission and vision statements?

D. What is your product?

E. Questions regarding customers.

1. Who is/are your customer(s)?

2. Do you know your customers personally?

3. How do you know if your customers are satisfied?

4. What kind of feedback do you have from your customers?

5. Do you measure this feedback? Why? How?

6. What do you do with these measurements?

7. Who are the ultimate customers of Systems Manufacturing?

8. Who are the ultimate customers of ACUSON?

F. Questions regarding suppliers.

1. Who is/are your suppliers(s)?

2. Do you know your suppliers personally?

3. How do you know if your suppliers are satisfied?

4. What kind of feedback do you have from your suppliers?

5. Do you measure this feedback? Why? How?

6. What do you do with these measurements?

7. Who are the primary suppliers of System Manufacturing?

8. Who are the primary suppliers of ACUSON?

G. Questions regarding measurements.

1. What do you measure in your job?

2. How do you decide what to measure in your job?

3. How do you measure it?

4. Do you have numerical goals and objectives?

5. Who sets your numerical goals and objectives?

6. If you have numerical goals, what happens if you don't meet them? If you exceed them?

7. Is your performance being measured?

8. Who measures your performance?

9. How is your performance being measured?

10. Are suggestions encouraged and are they measured?

11. What other criterion are being measured (morale, absenteeism, accident, etc)?

12. Other than the goals mentioned above, do you have other goals and objectives? If so, who sets them? Are they achievable goals? If not, why? and What happens if you exceed them?

H. Questions regarding processes.

1. Is the process for which you are in-charge being measured?

2. Who sets the goals and objectives for this process?

3. How is the process measured?

4. What happens if the process does not meet assigned goals and objectives?

I. Questions regarding setting strategies.

1. What is ACUSON'S strategy?

2. Does it fit ACUSON?

3. Is it implemented?

4. How and who sets this strategy?

5. What do you, personally, think about this strategy?

J. Questions regarding procedures.

1. Is your job or process documented?

2. Is the documentation accurate?

3. Who writes the documentation?

4. Can you change the documentation?

5. If you want to change a procedure, how long does it take to update the documentation?

K. Questions regarding individual evaluations.

1. How are you evaluated?

2. Do you feel you are evaluated fairly?

L. Questions regarding control of information.

1. How do you coordinate activities with your customers?

2. How do you coordinate activities with your suppliers?

3. If you have a problem with a preceding or subsequent process, who do you talk to about it?

4. If you see something wrong within the company, do you communicate it? If so, to whom? How?

M. Questions to managers.

1. What are the criterion you use to measure ASM each month?

2. Do you feel that these criteria are the most important criteria?

3. How do you feel about your authority and responsibility? Do you have enough freedom to make decide?

4. How are you evaluating your team members? Can we see an evaluation report?

5. Did you participated in the restructuring or layoff process?

6. What did you do about the recent survey results?

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